S/N 497 and above

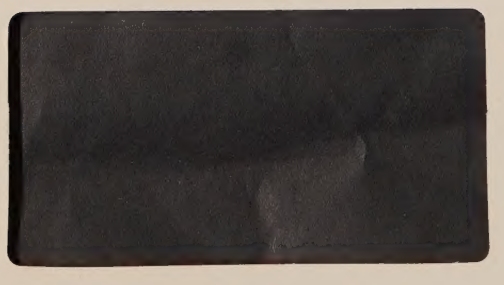
Electronic Services - Los Angeles
M12552X

Instruction Manual

MODEL 840A & 840B

ELECTRONIC
GALVANOMETER

FLUKE
ELECTRONICS FOR INDUSTRY
INSTRUMENTS / COMPONENTS



JOHN FLUKE MFG. CO., INC.
P.O. Box 7428 Seattle, Washington 98133

March 1, 1965

MODEL 840A & 840B

ELECTRONIC GALVANOMETER

840A & 840B serial no. 497 and above

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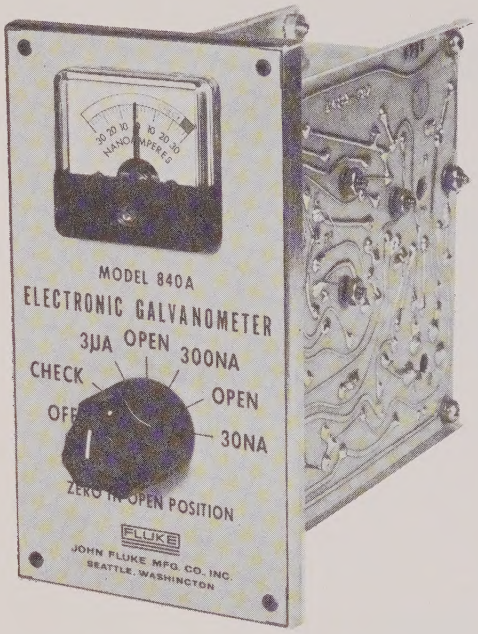
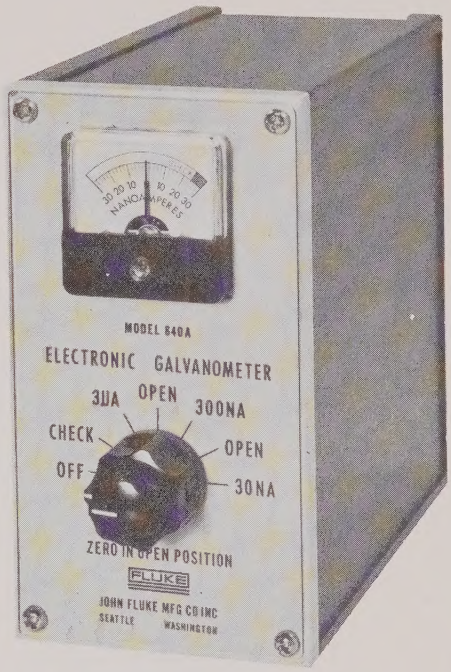
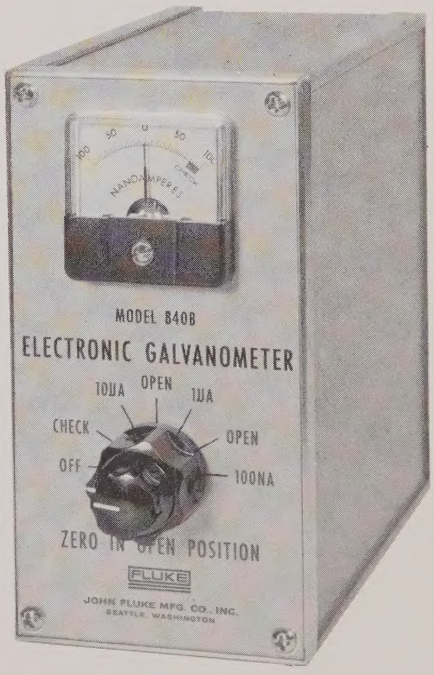


MODEL 840A



MODEL 840A with MODEL A84-1 case

MODEL 840B



MODEL 840B with MODEL A84-1 case

SECTION I

INTRODUCTION AND SPECIFICATIONS

1-1. INTRODUCTION

a. This instruction manual is for use with the 840A and 840B Electronic Galvanometer. The 840A and 840B are available ready for installation into another instrument (OEM applications) or mounted in a Model A84-1 Metal Instrument Case for general bench use. This instrument may be powered by a Model A84-2 Mercury Battery Kit, a Model A84-3 AC Power Pack, or a Model A84-4 Rechargeable Battery Pack.

b. The 840 series Electronic Galvanometers are current sensing devices with low input impedance. As such, they are basically equipped to make current measurements from 2 nanoamperes to 3 microamperes for the 840A and from 5 nanoamperes to 10 microamperes for the 840B in addition to use as a galvanometer. However, high voltage sensitivity is available for voltage measurements of low resistance sources in the low microvolt region. In addition, an output signal of approximately 100 millivolts from a source resistance of 1000 ohms is available for recording indications of the meter.

c. The 840 series has many advantages over virtually all conventional low-current sensors such as light beam galvanometers. Since the 840 series galvanometers contain no large mass to be moved by the signal to be measured, measurements can be made much faster than with light beam galvanometers. Maximum capabilities can be realized in virtually all situations because the dynamic response is independent of source resistance, and therefore, no damping resistors are required to improve the speed of measurement. Since the 840A series galvanometer are not affected appreciably by vibration and do not have to be level, they may be used in any position. In fact, they may be used on a somewhat unstable bench, in van-mounted instruments, or even held in the hand. Since the 840 series may be battery operated, coupling to power lines, which sometimes causes trouble with conventional electronic null detectors, can be greatly reduced. In addition, the high modulating frequency allows the use of a low pass filter to minimize the effects of external fields and AC input signals. Furthermore, as an additional feature not found on conventional galvanometers, the 840 series contains a recorder output which is totally isolated from the input.

d. In use, a transistor oscillator drives a magnetic modulator which is used as a current sensor. The modulator produces a second harmonic output with an amplitude proportional to the DC input current and of a phase depending on the polarity of the DC input. This AC voltage is amplified to a level that will drive a synchronous demodulator. The resultant DC current is then displayed on a zero-center panel meter.

1-2. DAMAGE IN SHIPMENT

Immediately upon receipt, thoroughly inspect for any damage that may have occurred in transit. If any damage is noted, follow the instructions outlined on the warranty page at the back of this manual.

1-3. INPUT POWER

The 840A and 840B require approximately 7 milliamperes at 13.5 volts. They may be powered from either the Model A84-2 Mercury Battery Kit, the Model A84-3 AC Power Pack, the Model A84-4 Rechargeable Battery Pack, or any power supply having an output voltage from 11.7 to 14 volts at 6 to 8 milliamperes with less than 30 millivolts ripple and 150 ohms source resistance. The Model A84-2 Mercury Battery Kit consists of two Mallory TR-135R batteries. These batteries will last approximately 150 hours under normal operating conditions. However, it should be remembered that the life of any dry type battery is reduced for operating temperatures below 70°F. Also, a severe loss of capacity will result for operation in the vicinity of 32°F. The Model A84-3 AC Power Pack may be used on a 115 or 230 volt (±10%) line with a frequency from 50 to 440 cycles. Like most Fluke instruments, the A84-3 AC Power Pack is normally supplied with dual primary winding connected in parallel for 115 volt operation. Upon request, power packs are supplied for 230 volt operation with the primary windings connected in series. If it becomes desirable to convert from one mode of operation to the other, refer to the instruction on the AC Power Pack.

1-4. SPECIFICATIONS

DC CURRENT SENSITIVITY:

-840A-

30-0-30 nanoamperes, full scale (2 na/scale div.)
300-0-300 nanoamperes, full scale (20 na/scale div.)
3-0-3 microamperes, full scale (200 na/scale div.)

-840B-

100-0-100 nanoamperes, full scale (5 na/scale div.)
1-0-1 microampere, full scale (50 na/scale div.)
10-0-10 microamperes, full scale (500 na/scale div.)

INPUT RESISTANCE: 840A approximately 180 ohms, all ranges. 840B approximately 18 ohms, all ranges.

ACCURACY AS A NANOAMMETER:
±10% of full scale, 10°C to 40°C
±15% of full scale, 0°C to 50°C

OUTPUT VOLTAGE:
Approximately 0.1 VDC for full scale deflection, 1000 ohms output resistance, one output binding post common to chassis.

NOISE: 840A less than 0.5 nanoampere RMS (2 nanoamperes peak-to-peak). 840B less than 1.5 nanoamperes RMS (6 nanoamperes peak-to-peak).

DRIFT: 840A less than 5 nanoamperes per hour after 30 seconds. 840B less than 15 nanoamperes per hour after 30 seconds.

SPEED OF RESPONSE:
Less than 1 second from center scale to 90% of reading. Speed is independent of source resistance; no damping resistors required.

INPUT ISOLATION FROM CHASSIS:
Greater than 10^9 ohms (100V maximum DC potential between chassis and input).

OVERLOAD:
At least 10 ma for 840A and 30 ma for 840B without damage.

AC COMMON MODE REJECTION
Up to 10 V RMS, 40 cps to 500 cps between chassis and input produces negligible reading error on any range.

AC NORMAL MODE REJECTION (Maximum allowable AC RMS Current):

-840A-

Range	50 cps	60 cps	120 cps
30 na	200 na	300 na	3 ua
300 na	5 ua	6 ua	60 ua
3 ua	50 ua	60 ua	600 ua

-840B-

Range	50 cps	60 cps	120 cps
100 na	500 na	1 ua	6 ua
1 ua	5 ua	10 ua	60 ua
10 ua	50 ua	100 ua	600 ua

TEMPERATURE RANGE:
Operating, 0°C to 50°C
Storage, -40°C to +85°C

HUMIDITY:
0 to 80%

POWER SUPPLY REQUIREMENTS: 11.7 to 14 volts at 6 to 8 milliamperes with less than 30 millivolts rms ripple and 150 ohms source resistance.

POWER SUPPLY OPTIONS:

A84-2 Mercury Battery Kit - Two Mallory TR-135R mercury batteries for approximately 150 hours of operation.

A84-3 AC Power Pack for 115/230 VDC (±10%), 50 to 440 cps, 1 watt operation.

A84-4 Rechargeable Battery Pack-Ten nickel-cadmum cells with recharging power supply for more than 100 hours operation on full charge. Metal case is included which mounts the 840 and the Battery pack side-by-side.

MOUNTING:
OEM Panel Mount - Unterminated wire leads for input, output, and external ON-OFF switching in addition to front panel ON-OFF switch.

Metal Instrument Case - Input and output leads terminated at rear terminal posts.

SIZE: Approximately 5-1/2" high x 3" wide x 4-3/4" behind front panel without case (case depth is 6-1/2" behind panel including rear terminals). Approximately 5-1/2" high x 6" wide x 6-1/2" behind front panel including rear terminals with rechargeable battery pack and case.

WEIGHT:
1-1/2 pounds without batteries and case.
3 pounds with batteries and case.

SECTION II

OPERATING INSTRUCTIONS

2-1. MOUNTING IN ANOTHER INSTRUMENT

To mount an 840 series electronic galvanometer in another instrument proceed as follows:

a. Prepare panel of instrument for mounting with the aid of Figure 2-1.

b. Mount galvanometer to panel of instrument with four 6-32 by 1/2 inch screws and four number 6 flat washers.

c. Solder red/white and yellow/white wire to instrument on-off switch if desired. Otherwise, twist these wires together, solder, and then suitable insulate. These wires are provided so that the operator does not have to remember to turn the function switch off to preserve battery life.

d. Connect red wire to positive input, black wire to negative input, and black/white wire (chassis ground) and orange wire to recorder.

2-2. MOUNTING IN A84-1 CASE

When a Model 840A or 840B Electronic Galvanometer (Figure 2-1) and a Model A84-1 Metal Instrument Case (Figure 2-2) are ordered together, they are assembled at the factory. However, if an 840A or 840B and an A84-1 case are ordered seperately, they may be assembled as follows:

a. Remove two screws at back of case and lift off sides.

b. Twist red/white and yellow/white wires together, solder, and then suitably insulate.

c. Solder red wire to + INPUT binding post, black wire to - INPUT binding post, black/white wire to grounded RECORDER binding post, and orange wire to ± RECORDER binding post.

d. If desired, serial number may be stamped on decal on back of case.

e. Fold extra lead length over top of chassis while placing galvanometer in approximate final position in case.

f. Replace side and fasten with two screws.

g. Mount galvanometer in case with four screws and washers provided.

2-3. INSTALLING BATTERIES

The Model A84-2 Mercury Battery Kit, two Mallory TR-135R batteries, may be installed as follows:

a. Remove four front panel screws fastening galvanometer to case assembly or instrument in which it is installed and slide out galvanometer.

b. Install batteries so that polarity marked on batteries matches polarity marked on battery clips. Note that the case of the mercury battery is positive.

c. Place galvanometer into case assembly or instrument and replace four screws.

2-4. INSTALLING AC POWER PACK

The Model A84-3 AC Power Pack may be installed as follows:

a. Remove four front panel screws fastening galvanometer to case assembly or instrument in which it is installed and slide out galvanometer.

b. If batteries are installed, remove from clips. Do not dispose of batteries by means of fire.

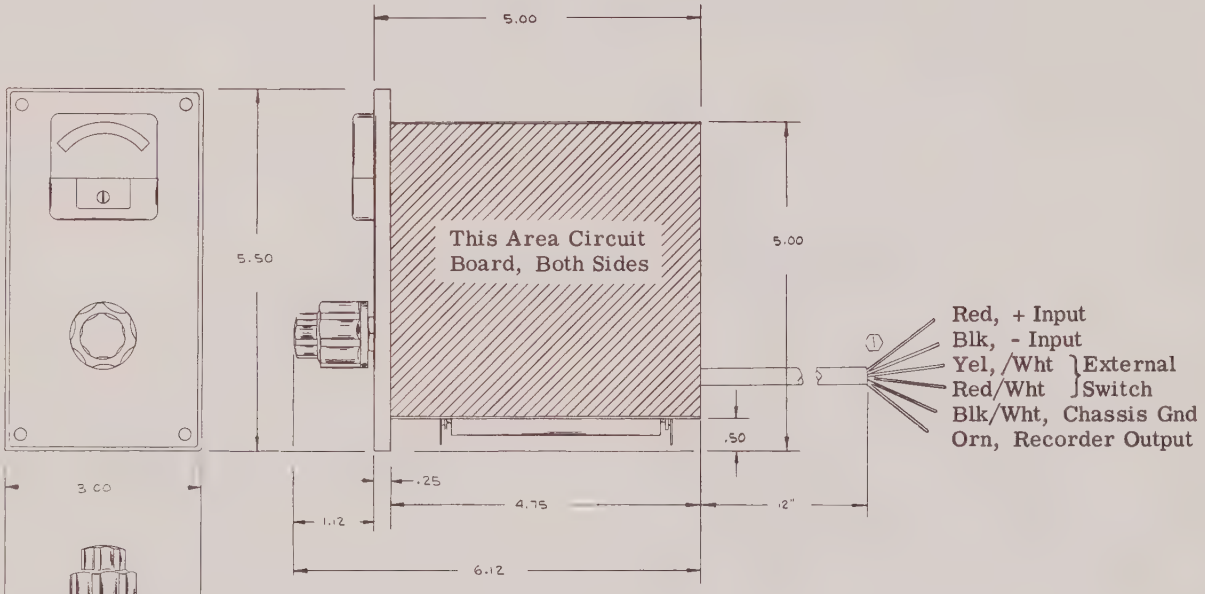
c. Pass cord through hole provided if galvanometer case is used.

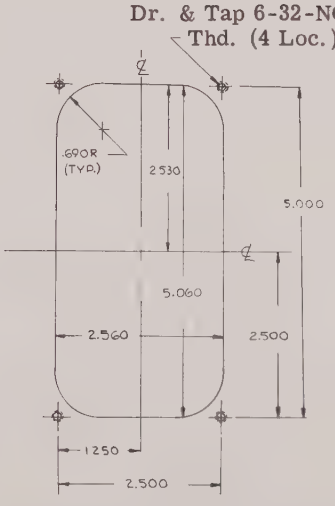
d. Connect lead with red thermofit to terminal with positive designation closest to front panel and lead with black thermofit to adjacent terminal with screws and nuts provided.

e. Place galvanometer into case assembly or instrument and replace four screws.

2-5. CONTROLS, TERMINALS AND INDICATORS

The circuit symbol and a functional description of all external controls, terminals, and indicators on the 840A and 840B Electronic Galvanometer may be found in Figure 2-3.





Instrument Mounting Hole Dims.

Figure 2-1. 840A, 840B AND MOUNTING DIMENSIONS

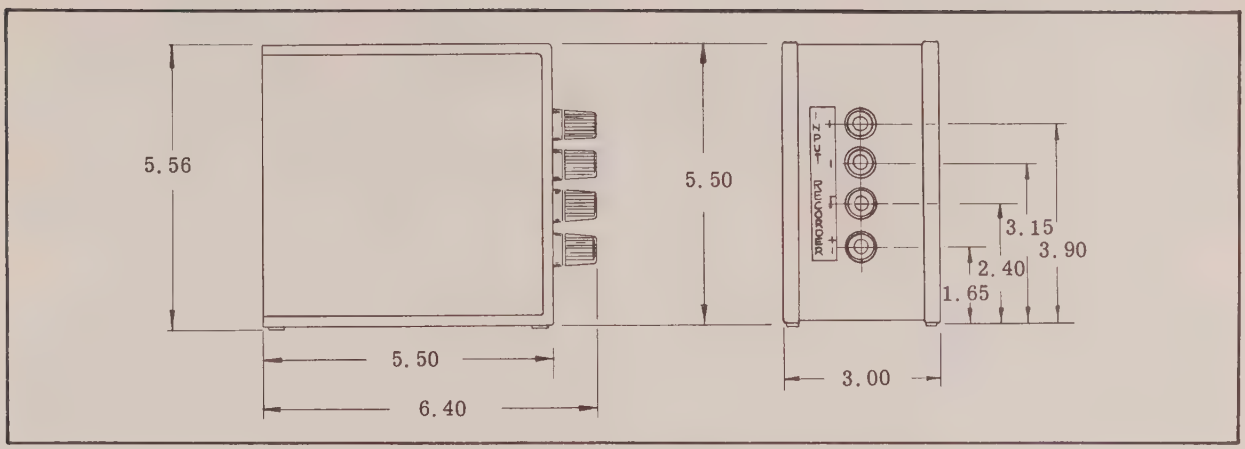


Figure 2-2. A84-1 METAL INSTRUMENT CASE DIMENSIONS

CONTROLS TERMINALS AND INDICATORS	CIRCUIT SYMBOL	FUNCTIONAL DESCRIPTION
Function switch	S1	Set to CHECK for determining condition of batteries. When set to either of the two OPEN positions, the input is open circuited and the meter sensitivity is the same as for the 30 NA position in the 840A and 100 NA position in the 840B. Full scale current ranges of 3 UA, 300 NA, and 30 NA for the 840A and 10 UA, 1 UA and 100 NA for the 840B are available. Should be set to OFF to prolong battery life when instrument is not in use.
Zero control	R4	Permits meter zero adjustment when function switch is in an OPEN position or cancelling out of circuit emf's in the range positions.
Meter	M1	Indicates amount of current flowing into input terminals when function switch is in a current range. A 30-0-30 scale is provided for full scale indications of 3 ua, 300 na, and 30 na for the 840A and a 100-0-100 scale is provided for full scale indications of 10 ua, 1 ua and 100 na for the 840B. A green area at positive end of scale, 24 to 30 for the 840A and 80 to 100 for the 840B, indicates condition of batteries when function switch is set to CHECK.
Mechanical zero screw	None	Sets meter to zero mechanically.
INPUT terminals or wires	J1, J2	Provided for connecting DC current or DC voltage to be measured. These terminals are rear panel binding posts on A84-1 case and red and black wires on panel mount instruments.
RECORDER terminals or wires	J3, J4	Provided for attaching a recorder to monitor meter excursions. These terminals are rear panel binding posts on A84-1 case and orange and white/black wires on panel mount instruments. The white/black wire is connected to the chassis.
External on-off switching wires	None	White/red and white/yellow wires provided for external on-off switching in addition to front panel on-OFF switch.

Figure 2-3. CONTROLS, TERMINALS AND INDICATORS

2-6. CURRENT MEASUREMENTS

To make current measurements from 2 nanoamperes to 3 microamperes with the 840A or 5 nanoamperes to 10 microamperes with the 840B, proceed as follows:

a. Connect current to be measured to INPUT terminals. Use shielded leads when working in an area of high fields or when using long leads.

CAUTION

Do not operate instrument by more than ±100 volts with respect to ground. Higher voltages may cause insulation failure.

b. Set function switch to CHECK. If meter needle indicates in green area, the batteries are satisfactory for use.

c. Advance function switch to 3 UA for 840A or 10 UA for 840B and record current. Meter needle deflection to the right indicates that conventional current is flowing into the positive terminal.

d. If current to be measured is too small to provide suitable deflection, zero galvanometer by advancing function switch to OPEN and adjusting zero control. Then advance function switch to 300 NA for 840A or 1 UA for 840B and record current.

e. If additional sensitivity is still needed, rezero galvanometer with function switch in second OPEN position and then advance function switch to 30 NA for 840A or 100 NA for 840B and record current.

f. Set function switch to OFF when instrument is not in use to prolong battery life.

2-7. VOLTAGE MEASUREMENTS

Voltage measurements in the microvolt region can be made with the 840A or 840B by converting the meter current indications to voltage by means of the system resistance. To make voltage measurements, proceed as follows:

a. Perform steps a. through f. of paragraph 2-6 as if making a current measurement.

b. Add galvanometer resistance (R_g = 180Ω for 840A and 18Ω for 840B) to source resistance (R_S) and multiply result by galvanometer current (I_g) to obtain source voltage $\boxed{E_s = I_g (R_g + R_s)}$

NOTE

The input resistance of the instrument is composed primarily of copper windings and therefore has a temperature coefficient of 0.4%°C. Also note that the voltage sensitivity decreases with increasing source impedance. For a source impedance of 180 ohms for 840A or 18 ohms for 840B, the voltage sensitivity is one-half the sensitivity with a low source impedance.

c. If source resistance is not known, make a second measurement with a resistor (R_a) in series with the instrument. This resistor should be a few hundred ohms for a low impedance source and larger for a high impedance source. If a significant number can not be obtained when the current with the resistor added is subtracted from the current without the resistor added, the value of the resistor should be increased. Calculated the source voltage from the following equation:

$$E_s = \frac{I_{g1}\ I_{g2}}{I_{g1} - I_{g2}}\ R_a$$

where I_{g1} = galvanometer current without R_a

I_{g2} = galvanometer current with R_a

R_a = resistance added in series.

2-8. USE AS A NULL DETECTOR

The 840A or 840B may be used to monitor current in bridge circuits, potentiometers, and other measuring equipment. In most of these applications the circuit is adjusted for zero deflection or a "null" on the galvanometer. To use the instrument as a null detector, proceed as follows:

a. Connect input terminals of instrument to circuit in which a null is desired.

CAUTION

Do not operate instrument by more than ±100 volts with respect to ground. Higher voltages may cause insulation failure.

b. Set function switch to CHECK. If meter needle indicates in green area, the batteries are satisfactory for use.

c. Advance function switch to 3 UA for 840A or 10 UA for 840B and adjust circuit for a null.

d. If a current smaller than 200 nanoamperes for 840A or 500 nanoamperes for 840B is significant in this application, zero galvanometer by advancing function switch to OPEN and adjusting zero control. Then advance function switch to 300 NA for 840A or 1 UA for 840B and adjust circuit for a null.

e. If a current smaller than 20 nanoamperes for 840A or 50 nanoamperes for 840B is significant; rezero galvanometer in second OPEN position, advance function switch to 30 NA for 840A or 100 NA for 840B, and adjust circuit for a null

NOTE

Since the instrument is a current responding device, as are light beam galvanometers, the source resistance is important when nulling two voltages. The voltage sensitivity is approximately 2 na (180 + R_S) per small division for the 30 NA range on the 840A and 5 na (18 + R_S) per small division for the 100 NA range on the 840B. Thus, the higher the source resistance, the lower the voltage sensitivity.

f. Set function switch to OFF when instrument is not in use to prolong battery life.

2-9. USE WITH A RECORDER

Recorder output is provided on the instrument for monitoring indications of the meter. The output signal is approximately 100 mv at full scale from a source resistance of 1000 ohms (±10%). Also note that one output

terminal is connected to the instrument case. It is recommended that a recorder with a level control be used in order to obtain the desired recorder deflection corresponding to full scale deflection of the instrument. To use the recorder, proceed as follows:

a. Connect recorder to RECORDER terminals.

b. Proceed as instructed for current measurements (paragraph 2-6), voltage measurements (paragraph 2-7), or use as a null detector (paragraph 2-8) as desired.

c. Set up recorder to operate as desired.

d. Rezero the instrument as required. This is most important when operating in the 30 NA range for 840A or 100 NA range for 840B since the drift may be almost 5 nanoamperes per hour for the 840A and 15 nanoamperes per hour for the 840B.

e. Set function switch to off when the instrument is not in use to prolong battery life.

2-10. NOTES ON OPERATION

a. CURRENT OVERLOAD. The instrument will withstand up to 10 milliamperes overload for the 840A and 30 milliamperes for the 840B without damage. However, if an overload of more than a few hundred microamperes is passed through the instrument, the internal oscillator will stop and the battery drain will increase somewhat. As a result the meter will indicate zero. To preserve battery life, an overload current should not be allowed to flow through the instrument for an extended period of time. The instrument should return to normal within a few seconds after the overload is removed. If difficulty in zeroing the instrument results, turning the instrument on and off a few times will correct the trouble.

b. THERMAL VOLTAGES. Erroneous measurements can often result from unwanted thermal voltages in the circuit being measured. For this reason the input terminals on the metal instrument case are made of solid copper with a gold coating. Nickel-plated brass connectors, such as ordinary banana plugs, should not be used in the input circuitry. Nickel to copper and other similar connections produce large thermal voltages compared to the low level signals of the instrument. If unwanted thermal voltages can not be eliminated, the effect can be reduced or eliminated by temporarily deactivating the circuit under measurement and cancelling out the thermal voltages by adjusting the zero control with the instrument in the desired range. The measurements taken with the circuit reactivated will not contain the error due to the thermal voltages, provided that they have not changed between the time the instrument was zeroed and the time of measurement.

c. MEASUREMENT DISCREPANCIES. If a discrepancy between two ranges exists in the measurement of a current, it is usually due to extermely high AC pickup. Unnecessary hum pickup in the circuit or system being measured can be reduced by using shielded leads. This is especially important when using long leads or when working in an area of high fields.

d. ZERO ADJUSTMENTS. When the function switch is in an open position, the meter sensitivity is the same as for the 30 nanoampere range on the 840A and 100 nanoampere range on the 840B. Thus, the zero control has no effect in the 3 microampere range for the 840A or 10 microampere range for the 840B and only a small effect in the 300 nanoampere range for the 840A or 1 microampere range for the 840B. When making prolonged measurements in the most sensitive range, the instrument should be rezeroed as required.

e. GROUNDING THE INPUT. The upper recorder terminal on the metal instrument case (white/black wire on panel mount instruments) is connected to the instrument chassis. This terminal may be connected to either input terminal by means of a copper wire. A shorting link should not be used for this purpose since materials used for shorting links might introduce thermal voltages into the low level input circuit. The grounded recorder terminal provides a convenient place to tie down any floating circuits to be measured when desired.

SECTION III

THEORY OF OPERATION

3-1. INTRODUCTION

a. Figure 3-1 shows the block diagram for the 840A and 840B Electronic Galvanometer. As seen in this figure, the circuit basically consists of a push-pull oscillator and frequency doubler, a magnetic modulator, a tuned carrier amplifier, a synchronous demodulator, and a meter. Refer to the functional schematic following Section V for more detail. This schematic is designed to aid in the understanding of circuit theory and trouble-shooting. The signal flow is from left to right and the components are laid out in a functionally logical manner.

b. The overall operation of the instrument may be summarized as follows. When a DC input signal is applied to the magnetic modulator, a signal is produced with an amplitude proportional to the DC input current and with a frequency that is the second harmonic of the oscillator frequency feed to the magnetic modulator. The second-harmonic signal is then amplified in the tuned carrier amplifier to a level which will drive the synchronous demodulator. The synchronous demodulator is also supplied with a second harmonic signal generated in the oscillator and frequency doubler. The synchronous demodulator delivers a DC current to the meter that is proportional to the amplitude of the second-harmonic signal from the amplifier and of a polarity depending on the phase of the amplifier second-harmonic signal with respect to oscillator signal.

c. In order to provide a more complete understanding of the Electronic Galvanometer, the following paragraphs describe each section of the circuit in detail.

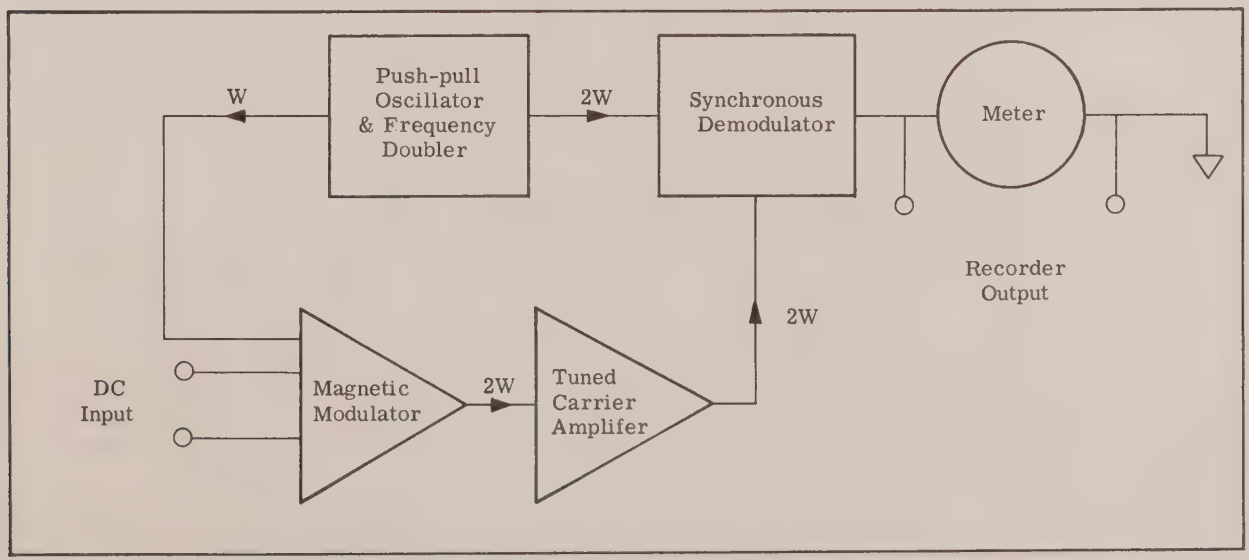


Figure 3-1. 840A & 840B ELECTRONIC GALVANOMETER BLOCK DIAGRAM

3-2. MAGNETIC MODULATOR

a. The operation of the 840A and 840B is made possible by the use of a magnetic modulator. A magnetic modulator is a device which uses a saturable core to obtain amplification or control of a signal. The oscillator supplies an alternating current at 2.5 kilocycles to the AC winding on magnetic modulator T2 by way of transformer T1. This winding is split into two identical, but oppositely wound, parts which are referred to as winding A and winding B. The oscillator is constructed such that the core of T2 reaches saturation during each AC cycle. However, as shown in Figure 3-2A, there is no net flux around the core of T2 because windings A and B are symmetrical. With the presence of a DC signal current through the DC winding on T2, greater flux saturation will occur on either the positive or negative flux crest of winding A and B depending on the direction of DC current. Figure 3-2B illustrates greater flux saturation on the positive flux crest due to a DC signal current. Since the positive flux crest of one winding opposes the negative crest of the other winding, a flux pulse will occur at twice the oscillator frequency as shown in Figure 3-2C. If the DC signal current is reversed, the flux pulse will be in the opposite direction, which means that the phase of the second-harmonic currents induced in the DC winding become reversed (changed 180°). It now becomes apparent that T2 is functioning as a modulator by producing an AC output signal at 5 kilocycles with an amplitude proportional to the magnitude of DC signal current and with a phase depending on the direction of DC current flow. Because the 5 KC wave carries the message, amplitude and phase of the DC input, it is called the carrier signal.

b. Resistors R3 and R4 supply an adjustable DC current from the 13.5 volt supply to two identical, but oppositely wound, windings on T2. This zero adjust circuit provides a method of cancelling out unwanted flux in the core.

3-3. TUNED CARRIER AMPLIFIER

a. The second-harmonic currents induced in the DC winding of T2 flow through C8 and T3 and thus induce the signal into the tuned carrier amplifier. At the input to the amplifier, the secondary of T3 and C9 form a parallel resonant circuit that selects the desired 5 KC signal from the other frequencies present. To prevent loading

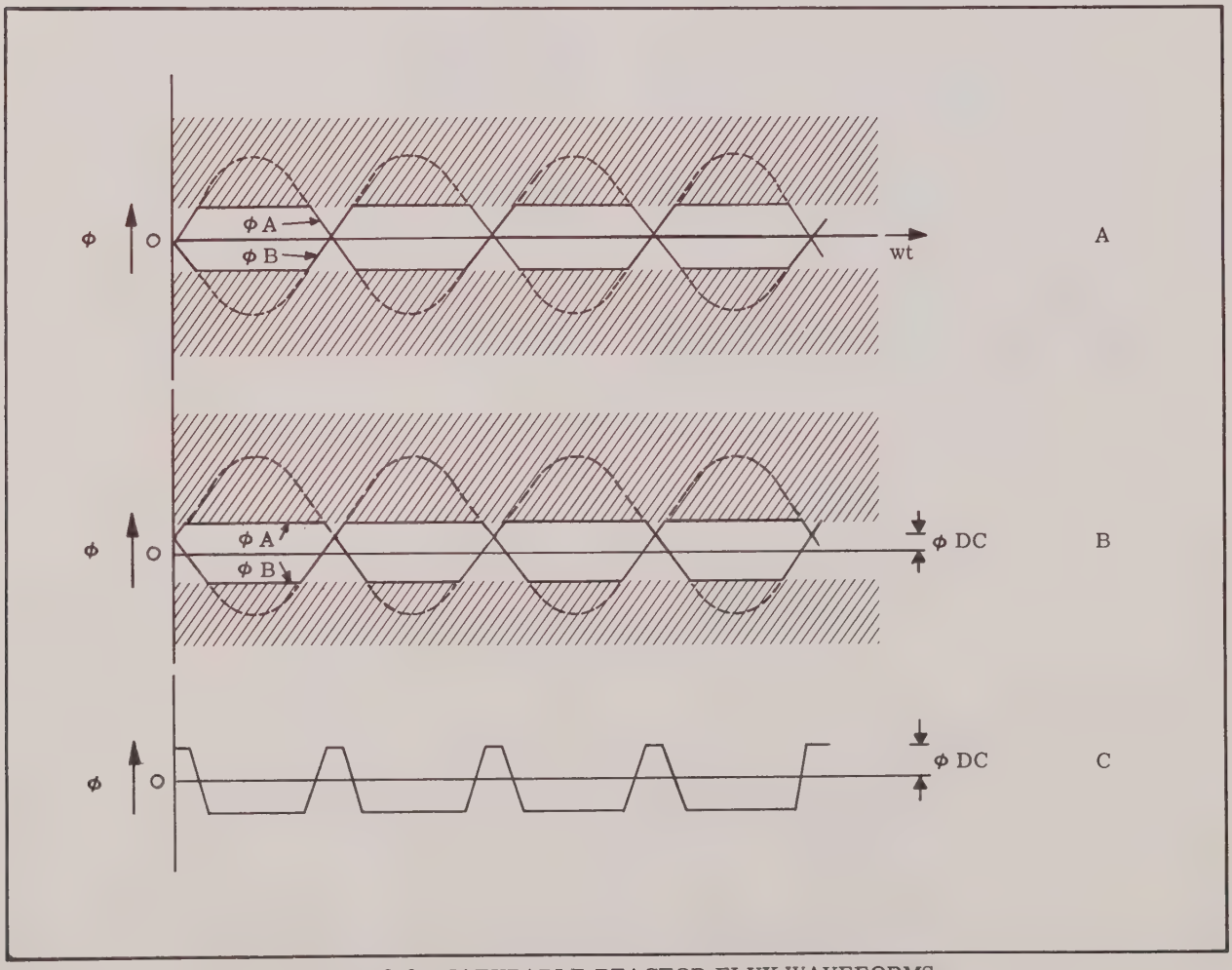


Figure 3-2. SATURABLE REACTOR FLUX WAVEFORMS

of the tank circuit, transistor Q6 is operated with emitter feedback from transistor Q7 which is operated as a grounded emitter stage. For the 30 NA (100 NA for 840B) and OPEN positions of the function switch, section S1C passes the signal from the collector of Q7 to the base of Q8 through capacitor C13. In the 300 NA and 3 UA (1 UA and 10 UA for 840B) positions, section S1C provides connection between an attenuator (R21 to R24) and the base of Q8 through C13 such that the signal is reduced by a factor of 10 and 100 respectively. Transistor Q8 is operated as a base input stage with emitter feedback to prevent loading of the attenuator. Transistors Q9 and Q10 operate as conventional, grounded emitter stages. A tuned series resonant circuit, composed of L1 and C15 in the emitter circuit of Q8, provides frequency-sensitive negative feedback from the emitter of Q10. Frequencies other than 5 KC encounter a large impedance in this tuned LC circuit and thus provide higher feedback which reduces the gain of Q8.

b. The cores of L1 and T3 are adjusted for maximum 5 KC output during calibration. The amplifier gain control R36 (R37 for serial numbers 123 to 496) is used to set the amplification of the amplifier to give full scale meter deflection with full range DC input.

3-4. PUSH-PULL OSCILLATOR AND FREQUENCY DOUBLER

a. The oscillator uses a push-pull tuned collector arrangement of Q1 and Q2. With this type of circuit, each transistor amplifies approximately half of the regenerative signal. As a result, a signal which is free from second-harmonic distortion is fed to the magnetic modulator.

b. The tank circuit consisting of capacitor C2 and the primary winding of transformer T1 in the collector circuits of Q1 and Q2 determines the frequency of operation. Tuning to 2.5 KC is obtained by means of the variable core of T1. The regenerative signal is applied between the base and emitter of each transistor by means of induced voltages from the signal windings on transformer T1. Capacitor C3 places the center tap of the signal winding at AC ground potential. The signal paths are then completed through R10. The output signal is induced into the output windings, two lower windings on T1, and feed directly to magnetic modulator T2. The amplitude of the oscillator is controlled by monitoring the current in the output windings through the use of dropping resistors R5 and R6. Transistor Q3 used this voltage drop to control the base current of the oscillator and therefore the output amplitude. Variable resistor R6 on serial numbers 497 and on is used to adjust the amplitude of the oscillator.

c. The push-pull oscillator circuit used here also provides the useful property of frequency doubling. Although each transistor only conducts approximately half the time, the emitter current of both transistors flows through R10 in the same direction. As a result, the waveform across R10 is a full-wave rectified 2.5 KC sine wave. Variable resistor R9 was used in serial numbers 123 to 496 to adjust for equal peaks of adjacent half cycles. The voltage developed across R10 forms the input trigger for the synchronous demodulator drive circuit.

3-5. SYNCHRONOUS DEMODULATOR

a. The carrier signal, which has been shown to contain both polarity and amplitude information of the DC input, cannot be detected by ordinary rectification without losing the polarity information. To obtain both polarity and amplitude information, it is necessary to supply a drive or reference signal of the same frequency and in phase with the carrier before the signal is converted to DC. This process of demodulating the carrier with a synchronous drive signal is called synchronous demodulation.

b. The synchronous drive signal comes from a circuit consisting of transistors Q4 and Q5 along with their associated circuitry. With no input, each transistor is conducting just about the same amount. However, the rectified 2.5 KC sine wave developed across R10 triggers the circuit into operation. As the voltage on the leading edge of a half cycle increases above the average value of the input wave, the base of transistor Q4 is driven more positive and the collector current increases. This increases the voltage drop across R15 and drives the emitter of Q5 more positive than the base thus turning off Q5. When the voltage on the lagging edge of the half cycle decreases below the average value, the base voltage of Q4 decreases, the transistor ceases to conduct, and Q5 will again conduct. Diodes CR4 through CR7 on the load side of the demodulator transformer act as a diode clipping circuit. This limits the voltage on the collectors of Q4 and Q5 thus producing a square wave.

c. The demodulator consists of transformer T4 and diodes CR4 through CR7. This is a balanced demodulator in that there is no output current through the meter when the carrier signal is absent. During one-half of a cycle, the current from transformer T4 flows through CR4 and CR5 and during the other half cycle the current flows through CR6 and CR7. However, with an input signal into the instrument, a signal current flows between the tuned carrier amplifier and transformer T4. During half the signal cycle, this current flows between T4 and ground by way of the diodes and during the other half cycle it flows between T4 and ground by way of the meter and diodes. If the polarity of the DC input is reversed, the carrier signal current will flow through the meter in the opposite direction.

SECTION IV

MAINTENANCE

4-1. INTRODUCTION

The 840A and 840B Electronic Galvanometers seldom require any maintenance. Periodic maintenance consists only of replacing the batteries as described in paragraph 4-2. A discussion of corrective maintenance including troubleshooting tips, waveform and signal checking, operating voltage level checking, charts, and illustrations is given in paragraph 4-3. Paragraph 4-4 delineates the equipment and procedures necessary to calibrate the instrument.

4-2. PERIODIC MAINTENANCE

a. The only periodic maintenance required is replacement of the batteries after approximately 150 hours of operation. This becomes evident when the meter will no longer indicate in the green area with the function switch set to the check position.

b. Replace the batteries with Mallory mercury batteries, type TR-135R. To replace the batteries, proceed as follows:

(1) Remove four front panel screws fastening galvanometer to case assembly or instrument in which it is installed and slide out galvanometer.

(2) Remove batteries from battery clips and dispose of batteries, but not by means of fire.

(3) Install new batteries so that polarity marked on batteries matches polarity marked on battery clips. Note that the case of the mercury battery is positive.

(4) Place galvanometer into case assembly or instrument and replace four screws.

4-3. CORRECTIVE MAINTENANCE

a. GENERAL. Since the 840A and 840B Electronic Galvanometers are completely transistorized instruments of conservative design, the possibility of component failure is greatly reduced. Under normal circumstances, the only thing that will interfere with the performance of the instrument is improper tuning due to such things as aging and severe vibration. This will become evident by a reduction in sensitivity and difficulty in zeroing the instrument. In this case it will be necessary to calibrate the instrument as described in paragraph 4-4. If, however, the instrument does not perform correctly after calibration, the following portion of this paragraph may be used by the technician as a complete guide for locating and correcting the source of trouble. All equipment required for maintaining the instrument is listed in Figure 4-1.

EQUIPMENT	SPECIFICATIONS REQUIRED	USE	RECOMMENDED INSTRUMENT
Oscilloscope	Sweep range: 50 usec/cm to 1 msec/cm Sensitivity: 50 mv/cm	Calibration and Troubleshooting	Hewlett - Packard Model 120B Oscilloscope
Differential Voltmeter	Must be able to measure 3 volts (10 volts for 840B) with an accuracy of 1%	Calibration and Troubleshooting	Any Fluke 800 series model differential voltmeter
Power Supply	Must be able to supply 3 volts (10 volts for 840B) with a resolution of 30 mv (100 mv for 840B)	Calibration and Troubleshooting	Fluke Model 407D Power Supply
Resistor	1 megohm ±1%	Calibration and Troubleshooting	Any 1M ±1% resistor
Frequency Counter	Must be able to measure 2.5 kc with an accuracy of 0.1% ± 1 count	Calibration	Hewlett - Packard Model 521 Electronic Counter
AC Voltmeter	Range: 400 uv to 150 mv Accuracy: 3%	Troubleshooting	Fluke Model 910A True RMS Voltmeter
VTVM	Range: 1.5 to 15 VDC full scale Accuracy: 3%	Troubleshooting	RCA Voltohmyst

Figure 4-1. CALIBRATION AND TEST EQUIPMENT

SYMPTOM	PROBABLE CAUSE	REMEDY
Zero control will not null meter	Magnetic modulator saturated	Turn function switch from OFF to 3 UA for 840A or 10 NA for 840B at least three times. Check again in ZERO position.
	Galvancmeter not tuned	Recalibrate per paragraph 4-4
	Faulty magnetic modulator	Replace magnetic modulator
Meter noise exceeds 1 small division peak-to-peak	Defective feedback network	Check C4 and R8 and replace if necessary
Meter does not indicate in green area with function switch set to CHECK	Batteries at end of life	Replace batteries
	Batteries installed with wrong polarity	Reinstall batteries observing their proper polarity as marked on batteries and battery clips
	Circuit board not grounded	Connect land pattern at both edges of board to chassis when servicing a disassembled instrument
Measurements are out of tolerance on one range	Defective switch (S1)	Check switch contacts. If defective, repair or replace
	Defective attenuator resistor (R21 through R24)	Locate faulty resistor and replace

Figure 4-2. TROUBLESHOOTING CHART

b. TROUBLESHOOTING TIPS. The purpose of troubleshooting is to quickly and accurately correct the cause of any abnormal condition. Thus, servicing should begin with an attempt to localize the general area of trouble. Start by determining whether the battery voltage is high enough to operate the instrument; set the function switch to the check position and if the meter indicates in the green area the batteries are satisfactory for use. To assist in localizing some of the more common troubles that might occur, the causes and remedies for a number of symptoms are listed in the troubleshooting chart (Figure 4-2). Next make a quick thorough visual inspection. Look for loose, dirty, or intermittent connections and any other condition which suggests a source of trouble. If a visual inspection fails to reveal the trouble, proceed with waveform and signal checking.

c. WAVEFORM AND SIGNAL CHECKING. The fastest troubleshooting technique is a waveform and signal check. Make sure the push-pull oscillator is operating correctly by comparing the waveform between chassis ground and the junction of C5 and R10, test point A, with that shown in Figure 4-4A. Also compare output waveform between ground and collector of Q4, test point D, with that shown in Figure 4-4B. The synchronous demodulator may be checked by comparing the waveform between chassis ground and the junction of CR4 and CR6 with that shown in Figure 4-4C. Start signal check by connecting equipment as shown in Figure 4-6 and adjusting the power supply for 3 volts (±30 mv) for the 840A or 10 volts (±100 mv) for 840B. Check signal voltages at transistor terminals for which values are listed in Figure 4-5. Figure 4-3 may be used to locate the transistor terminals. When making measurements on printed circuit boards, use a sharp probe and press firmly while rotating probe to break through the insulating coating.

CAUTION

When measuring voltage, it is recommended that care be used to avoid momentary short circuits which could damage components.

Figure 4-4D illustrates the signal waveform that should appear at the collector of Q10 for a 3 ua input to the 840A or 10 ua input to the 840B. These checks just outlined will localize any trouble within the instrument to a particular stage.

d. OPERATING VOLTAGE LEVEL CHECKING. When the trouble has been localized to a stage, either through waveform and signal checking or some other means, the defective part may be isolated by operating level voltage measurements at the transistor terminals. Measurements that differ widely from those listed in the transistor voltage chart (Figure 4-5) can be used along with the schematic diagram to localize the trouble to a specific part, in most cases.

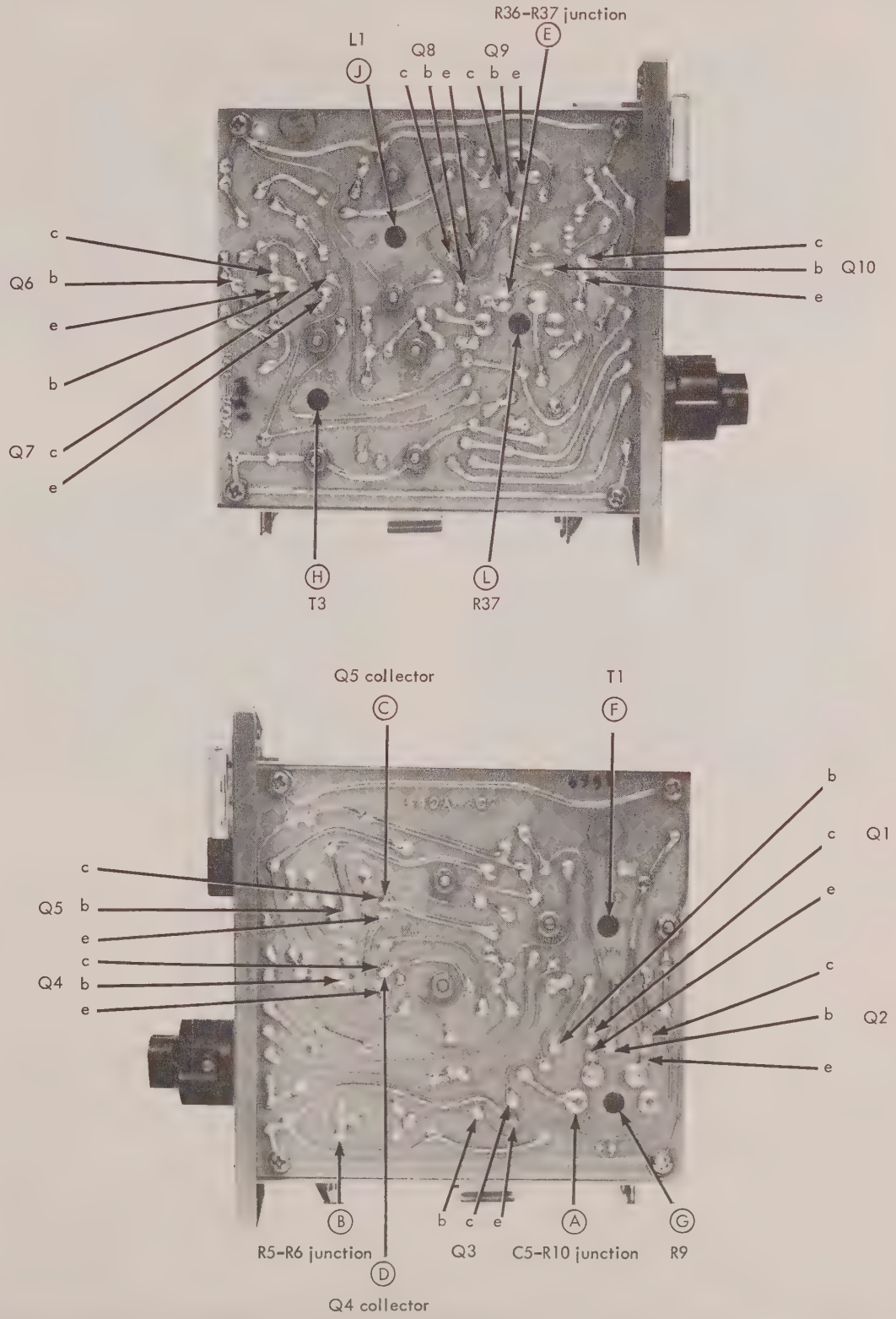


Figure 4-3A. TRANSISTOR TERMINAL, TEST POINT AND ADJUSTMENT LOCATIONS
(Serial numbers 123 to 496)

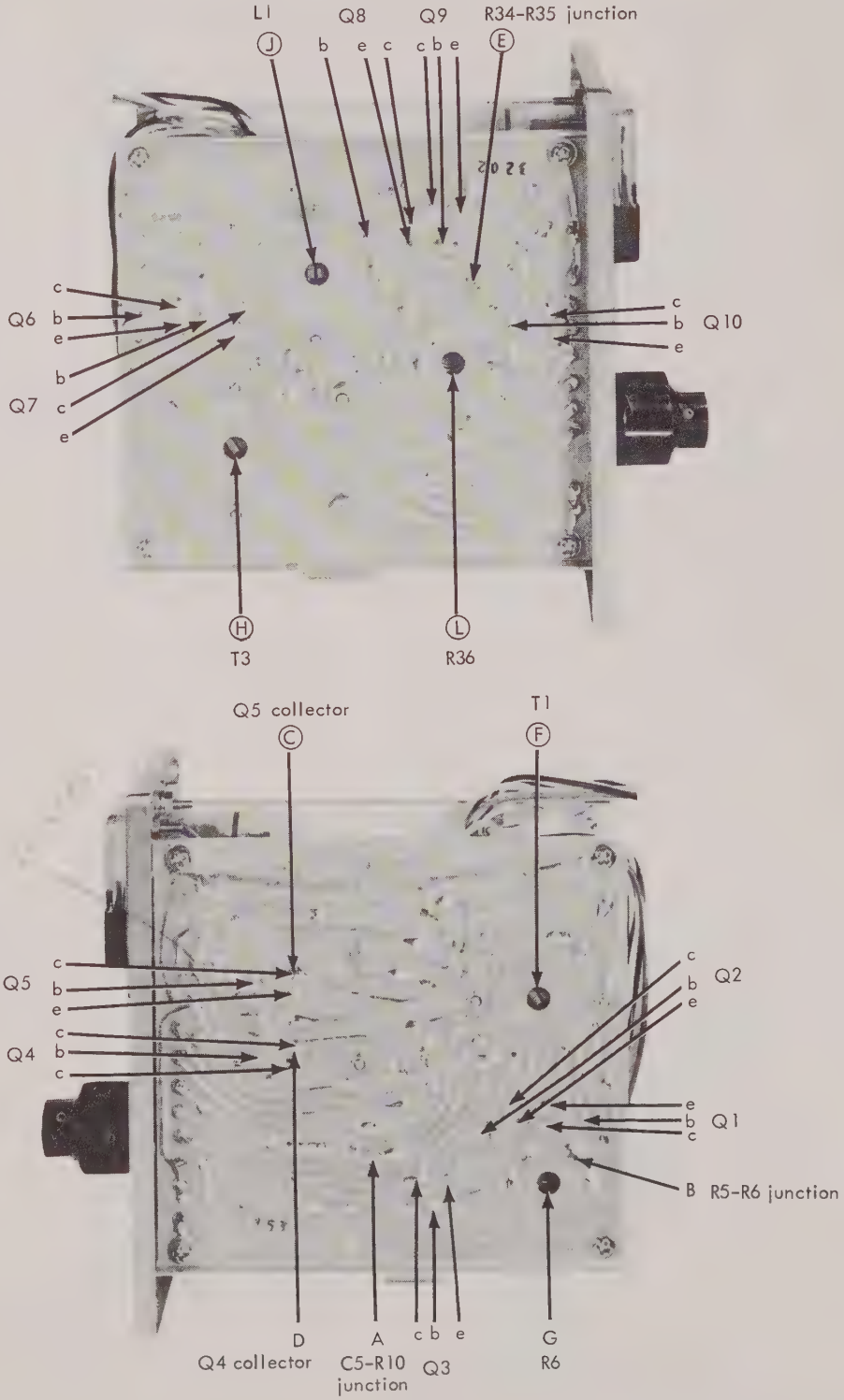
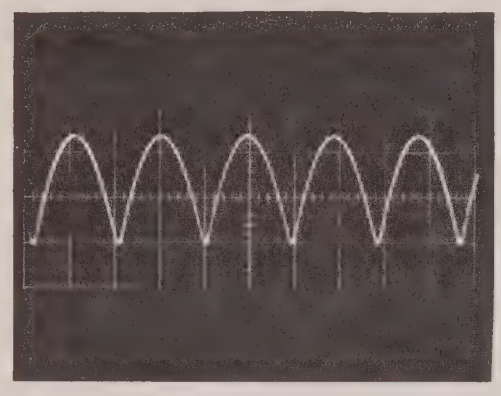
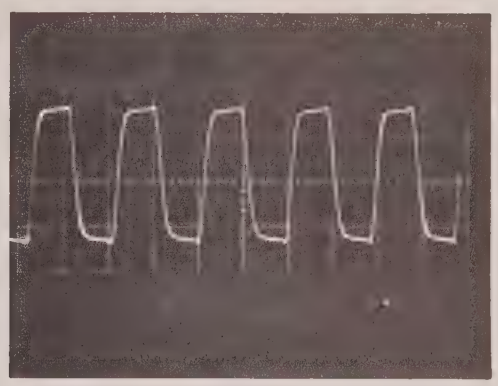


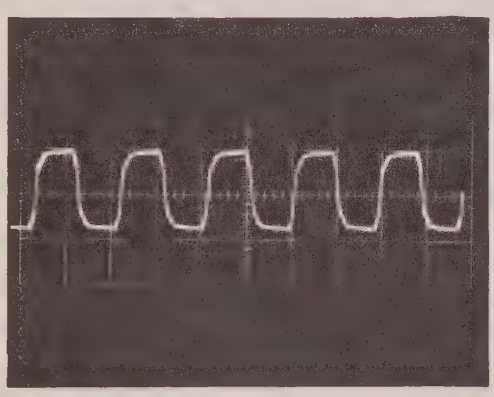
Figure 4-3B. TRANSISTOR TERMINAL, TEST POINT AND ADJUSTMENT LOCATIONS
(Serial numbers 497 and on)



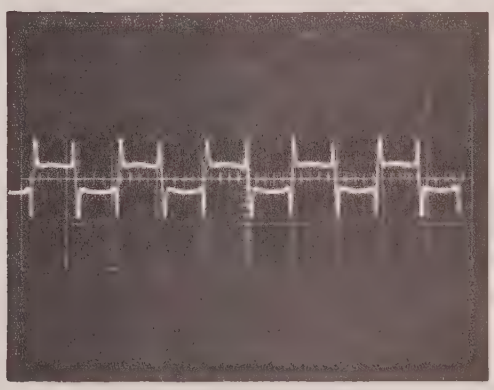
A. Waveform at Test Point A
(. 1 msec/cm, . 2 volt/cm)



B. Waveform at Test Point D
(. 1 msec/cm, 2 volt/cm)



C. Waveform at Junction of
CR4 and CR6 (. 1 msec/cm, 1 volt/cm)



D. Waveform at Collector of Q10
with 3 ua Input for 840A and 10 ua Input
for 840B (. 1 msec/cm, . 2 volt/cm)

Figure 4-4. 840A and 840B CIRCUIT WAVEFORMS

e. TRANSISTOR REPLACEMENT. The transistors used in the 840A and the 840B have been soldered directly into the circuit because of their high reliability. Before replacing transistors, their operation in the circuit should be checked as outlined in paragraphs 4-3c and 4-3d.

f. AC POWER PACK. The output voltage of the A84-3 AC Power Pack is approximately 14 volts at no load. The output voltage should remain within 13 to 14. 5 volts as the line voltage is varied from 103. 5 to 126. 5 volts. Since the output resistance is approximately 110 ohms, the output will drop approximately 0. 8 volts when the power pack is connected to the 840A or 840B. The ripple should be less than 10 mv rms over the entire line voltage range of 103. 5 to 126. 5 volts.

4-4. CALIBRATION

a. GENERAL. It is recommended that calibration of the 840A or 840B be performed every six months. The recommended equipment and the specifications required for calibration are shown in Figure 4-1. A nonferrous blade type screwdriver must be used for the adjustment of all cores.

b. OSCILLATOR AMPLITUDE ADJUSTING (ser 497 and on only).

(1) Set junction switch to 3 UA for 840A ro to 10 UA for 840B.

(2) Connect oscilloscope vertical INPUT between junction of R5 and R6 (test point B) and chassis ground.

TRANSISTOR	OPERATING LEVEL VOLTAGES			SIGNAL VOLTAGES		
	Base	Emitter	Collector	Base	Emitter	Collector
Q1	0.46 0.46	0.7 0.7	13.4 13.4	——— 600mv	——— 230mv	——— 7.2
Q2	0.46 0.46	0.7 0.7	13.4 13.4	——— 600mv	——— 230mv	——— 7.2
Q3	0 0	0 0	0.46 0.46	——— 170mv	——— ———	——— ———
Q4	6.5 6.5	6.4 6.4	13.5 13.5	——— 600mv	——— ———	——— ———
Q5	6.5 6.5	6.4 6.4	13.5 13.5	——— ———	——— ———	——— ———
Q6	1.1 1.1	.95 .95	5.2 5.2	27mv 44mv	27mv 44mv	——— ———
Q7	5.2 5.2	5.3 5.3	1.8 1.8	——— ———	——— ———	70mv 120mv
Q8	3.5 2.1	3.3 1.9	9.2 9.4	700uv 1.2mv	——— ———	——— ———
Q9	9.2 9.4	9.3 9.5	3.3 4.7	440uv 550uv	——— ———	——— ———
Q10	3.3 4.7	3.2 4.5	9.3 7.9	100mv 100mv	94mv 94mv	——— ———

Use upper figure for serial numbers 123 to 496 and lower figure for serial numbers 497 and on.

Operating level voltages measured under the following conditions: (a) function switch set to 3 UA for 840A and 10 UA for 840B; (b) no input; (c) all measurements made from ground to specified terminal with a 10 megohm voltmeter; (d) all voltages are DC; (e) voltages may vary as much as 15 to 20%; (f) bias voltages (difference between emitter and base voltages) should remain approximately the same.

Signal voltages measured under the following conditions: (a) function switch set to 3 UA for 840A and 10 UA for 840B; (b) 3 ua input for 840A and 10 ua input for 840B; (c) all measurements made from ground to specified terminal with an rms voltmeter; (d) all voltages are AC rms; and (e) voltage may vary up to 20%.

Figure 4-5. TRANSISTOR VOLTAGE CHART

(3) Set switches on oscilloscope for 1 volt per centimeter and 200 microseconds per centimeter.

(4) Adjust R6 at test point G for a peak-to-peak indication of 1.2 (±0.1) volts.

c. OSCILLATOR FREQUENCY TUNING.

(1) Set function switch to 3 UA for 840A or 10 UA for 840B.

(2) Connect electronic counter between junction of R5 and R6 (test point B) and chassis ground.

(3) Set up counter to measure a frequency of 2500 cps.

(4) Adjust core of T1 at test point F for a frequency of 2500 (±5) cps.

d. OSCILLATOR SECOND-HARMONIC ADJUSTING. (ser 123 to 496 only).

(1) Set function switch to 3 UA.

(2) Connect oscilloscope vertical INPUT to junction of C5 and R10 (test point A) and ground to 840A chassis.

(3) Set controls on oscilloscope for 100 millivolts per centimeter and 200 microseconds per centimeter.

(4) Adjust R9 at test point G for equal positive peaks on waveform (see Figure 4-4 part A).

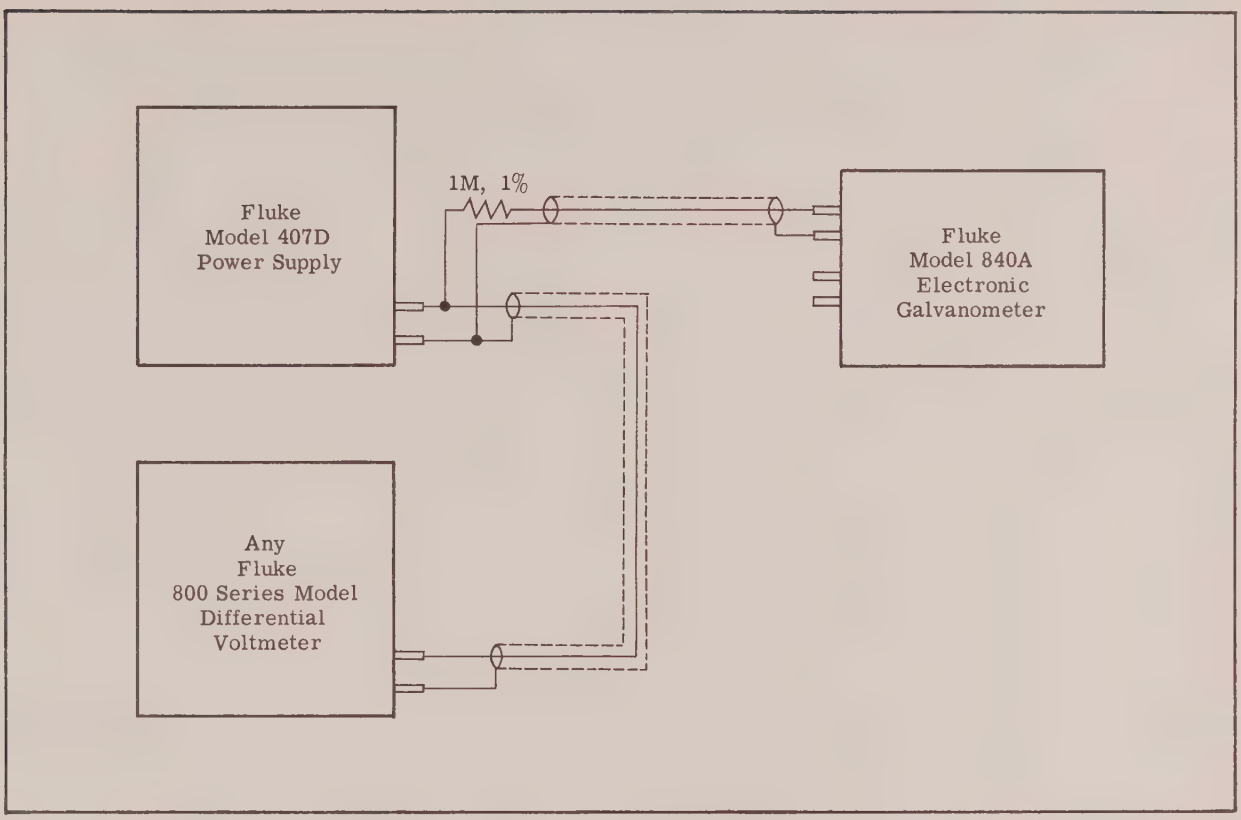


Figure 4-6. INPUT SIGNAL SET-UP FOR TROUBLESHOOTING AND CALIBRATION

e. CARRIER AMPLIFIER TUNING.

(1) Connect equipment as shown in Figure 4-6 and adjust power supply for 3 volts (±30 mv) for 840A or 10 volts (±100 mv) for 840B as measured with a differential voltmeter.

(2) Connect oscilloscope vertical INPUT to junction of R34 and R35 (R36 and R37 for ser 123 to 496) at test point E, TRIGGER INPUT to junction of R5 and R6 at test point B, and ground to galvanometer chassis.

(3) Set function switch to 3 UA for 840A or 10 UA for 840B.

(4) Set controls on oscilloscope for 100 millivolts per centimeter and 50 microseconds per centimeter.

(5) Adjust core of T3 at test point H for a maximum 5 KC signal on oscilloscope.

(6) Adjust core of L1 at test point J for maximum meter indication.

(7) Repeat steps (5) and (6) until both maximums occur at the same time.

f. CARRIER AMPLIFIER GAIN ADJUSTMENT.

(1) Connect equipment as shown in Figure 4-6 and adjust power supply for 3 volts (±30 mv) for 840A or 10 volts (±100 mv) for 840B as measured with a differential voltmeter.

(2) Set function switch to OFF and null meter with mechanical zero screw.

(3) Set function switch to OPEN between 3 UA and 300 NA positions for 840A or 10 UA and 1 UA positions for 840B and null meter with zero control.

(4) Set function switch to 3 UA for 840A or 10 UA for 840B.

(5) Adjust R36 (R37 for ser 123 to 496) at test point L for full scale deflection of meter.

(6) Reverse input to galvanometer and note meter indication.

(7) If error exists between positive and negative deflections of meter, split the difference with the gain adjustment control R36 (R37 for ser 123 to 496) at test point L.

SECTION V

LIST OF REPLACEABLE PARTS

5-1. GENERAL

a. The following assembly lists describe all normally replaceable parts of the Model 840A and 840B Electronic Galvanometer. Each list has a corresponding illustration on which the parts for that list are pointed out. Parts are called out on both lists and illustrations by reference designations from the schematic diagram. Those parts (mechanical) which have no reference designation are shown on the illustrations by Fluke Stock Number.

b. A Use Code column is provided to identify certain parts that have been added, deleted, or modified during production of the 840. Each part for which a use code has been assigned may be identified with a particular instrument serial number by consulting the Use Code Effectivity List at the end of this section.

5-2. HOW TO OBTAIN PARTS

a. Standard components have been used whenever possible. Thus, most parts may be obtained locally. However, special components are used in some instances. All parts manufactured or altered by Fluke and all parts for which Fluke controls the design are designated by an asterisk preceding the Fluke stock number. All structural parts and special parts should be purchased from your local Fluke representative or from the factory.

b. When ordering parts always include:

(1) Reference designation, description, and Fluke stock number.

(2) Instrument model and serial number.

(3) Most structural parts are not listed. In this case, give complete description, function, and location for the part.

REFERENCE DESIGNATION	DESCRIPTION		FLUKE STOCK NO.	USE CODE
	Final Assembly			
	Magnetic Modulator-Carrier Amplifier Assembly (See Figure 5-2)	840A 840B	*151589 *165803	
	Oscillator-Sychronous Demodulator Assembly (See Figure 5-3)		*151597	
	Upper Chassis Assembly		*152512	
	Lower Chassis Assembly with Battery Holder		*151555	
	Front Panel Assembly		*151415	
	Front Panel Decal	840A 840B	*152504 *165795	
	Knob, 1 inch with index line		150557	
	Knob, 3/4 inch with index line		150565	
M1	Meter, 100-0-100 microamp ±2%, 1K ±10%	840A 840B	*150326 *165894	
	Switch Assembly		*151605	
R1	Resistor, metal film, 143K ±1%, 1/2W		151506	
R2	Resistor, composition, 2.2K ±10%, 1/2W		108605	
R23	Resistor, metal film, 200Ω ±1%, 1/2W		151840	
R24	Resistor, metal film, 22.1Ω ±1%, 1/2W		151472	
R4, S1	Switch, rotary (Resistor, variable wirewound, 1 Meg, part of switch)		*152496	

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
	Accessories (See Figure 5-1)		
	Case	A84-1	
J1, J2	Binding post, red	149856	
J3	Binding post, black	142984	
J4	Binding post, red	142976	
BT1, BT2	Battery Kit, set of two 6.75V mercury batteries, Mallory 2-TR-135-R	A84-2	
	Auxiliary Power Supply (See Figure 5-4)	A84-3	

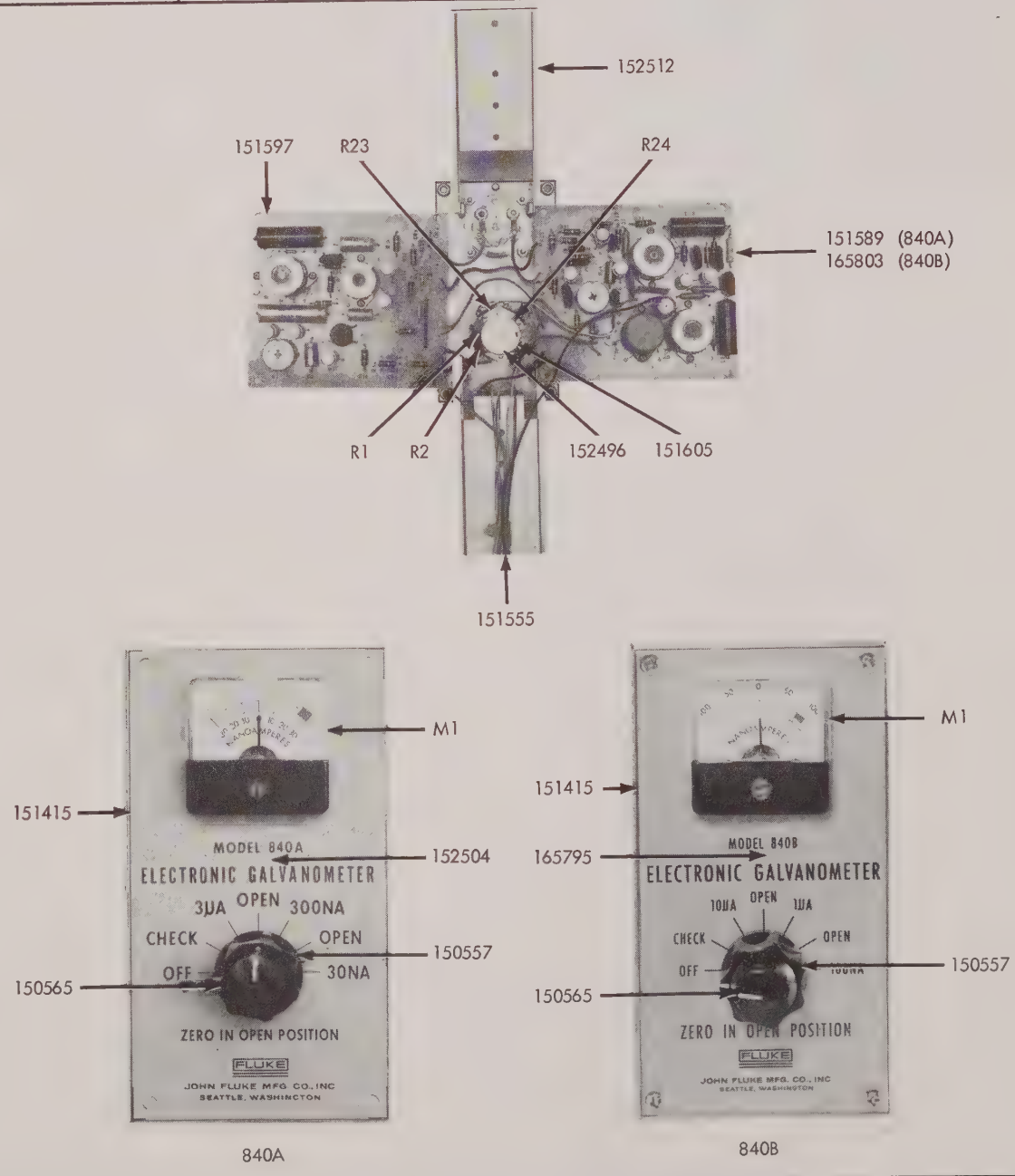
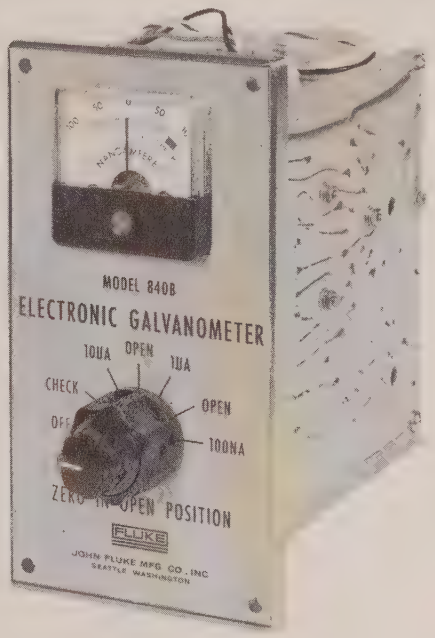


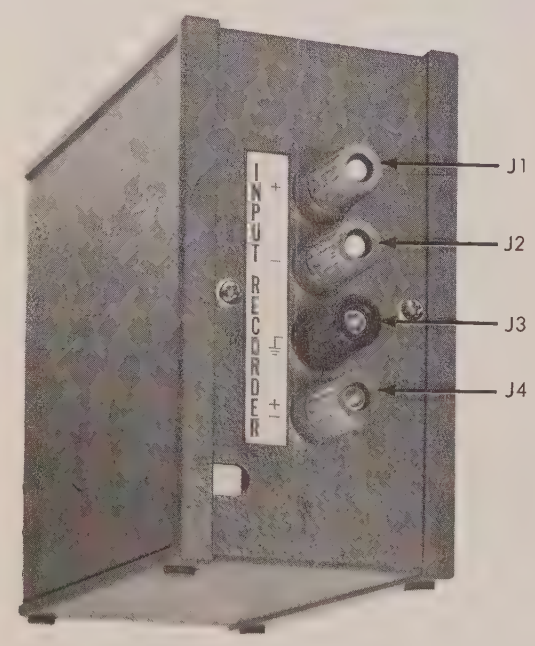
Figure 5-1. FINAL ASSEMBLY (sheet 1 of 2)

840A



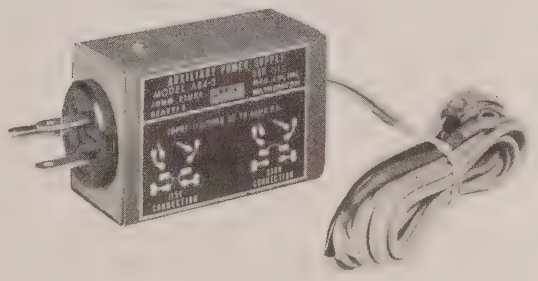
840B

ELECTRONIC GALVANOMETER



A84-1
METAL INSTRUMENT CASE

A84-2
MERCURY BATTERY KIT



A84-3
AUXILIARY POWER SUPPLY

Figure 5-1. FINAL ASSEMBLY (sheet 2 of 2)

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
	NOTE: This assembly applies to serial numbers 123 to 496 only.		
	Magnetic Modulator-Carrier Amplifier Assembly (Fig. 5-2)	*151589	
C8	Capacitor, electrolytic, 300 uf -10/+75%, 3V	151936	
C9	Capacitor, plastic, 0.047 uf ±10%, 50V	150300	
C10 thru C12	Capacitor, ceramic, 0.2 uf -20/+80%, 25V	151985	A
	(If replacement is required, use 161349)		
	Capacitor, tantalum, 0.47 uf ±20%, 35V	161349	B
C13, C14	Capacitor, ceramic, 0.05 uf -20/+80%, 25V	148924	C
	(If replacement is required, use 161349)		
	Capacitor, tantalum, 0.47 uf ±20%, 35V	161349	D
C15	Capacitor, plastic, 0.047 uf ±10%, 50V	150300	
C16	Capacitor, ceramic, 0.47 uf -20/+80%, 25V	151977	A
	(If replacement is required, use 161349)		
	Capacitor, tantalum, 0.47 uf ±20%, 35V	161349	B
C17	Capacitor, ceramic, 0.1 uf -20/+80%, 25V	148932	C
	(If replacement is required, use 161349)		
	Capacitor, tantalum, 0.47 uf ±20%, 35V	161349	D
C18	Capacitor, ceramic, 0.2 uf -20/+80%, 25V	151985	A
	(If replacement is required, use 161349)		
	Capacitor, tantalum, 0.47 uf ±20%, 35V	161349	B
C19	Capacitor, ceramic, 2.2 uf -0%, 3V	106393	C
	(If replacement is required, use 161943)		
	Capacitor, tantalum, 4.7 uf ±20%, 6V	106898	D
	(If replacement is required, use 161943)		
L1	Inductor, variable wirewound, 22mh nominal	*151654	
Q6	Transistor, germanium, NPN, 2N1304	117127	
Q7	Transistor, germanium, PNP, 2N1307	148643	
Q8	Transistor, germanium, NPN, 2N1304	117127	
Q9	Transistor, germanium, PNP, 2N1307	148643	
Q10	Transistor, germanium, NPN, 2N1304	117127	
R3	Resistor, composition, 12 Meg ±10%, 1/2W	152744	
R16	Resistor, wirewound, 1K ±20%, 1/2W	*152736	
R17	Resistor, metal film, 47.5K ±1%, 1/2W	148908	
R18	Resistor, metal film, 15K ±1%, 1/2W	151498	
R19	Resistor, composition, 5.6K ±10%, 1/2W	108324	
R20	Resistor, composition, 10K ±10%, 1/2W	108118	
R21	Resistor, metal film, 1.37K ±1%, 1/2W	148874	
R22	Resistor, metal film, 634Ω ±1%, 1/2W	148866	
R25	Resistor, composition, 12K ±10%, 1/2W	108977	
R26	Resistor, composition, 47K ±10%, 1/2W	108480	
R27	Resistor, composition, 18K ±10%, 1/2W	108183	
R28	Resistor, composition, 4.7K ±10%, 1/2W	108381	
R29	Resistor, composition, 8.2K ±10%, 1/2W	109017	
R30	Resistor, metal film, 33.2Ω ±1%, 1/2W	148882	

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
R31	Resistor, composition, 8.2K ±10%, 1/2W	109017	
R32, R33	Resistor, composition, 3.9K ±10%, 1/2W	152751	
R34	Resistor, wirewound, 5K ±2%, 1/2W	150672	
R35	Resistor, composition, 4.7K ±10%, 1/2W	108381	
R36	Resistor, composition, 2.7K ±10%, 1/2W	108837	
R37	Resistor, variable wirewound, 500Ω ±10%, 1/2W	112433	
T2	Magnetic Modulator	*151548	
T3	Transformer, 5 KC tunned	*151647	

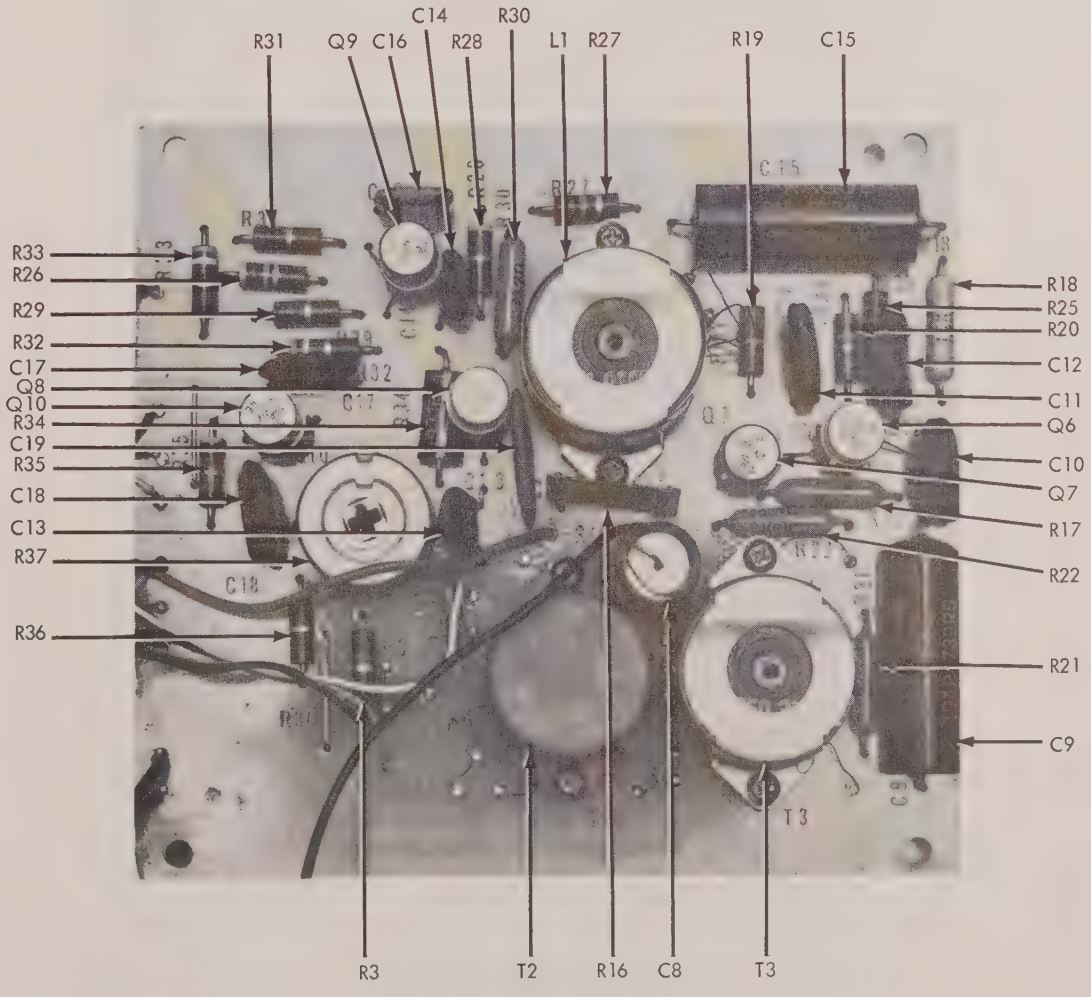


Figure 5-2A. MAGNETIC MODULATOR-CARRIER AMPLIFIER ASSEMBLY
(Serial Numbers 123 to 496)

REFERENCE DESIGNATION	DESCRIPTION		FLUKE STOCK NO.	USE CODE
	NOTE: This assembly applies to serial numbers 497 and on only.			
	Magnetic Modulator-Carrier Amplifier Assembly (See Figure 5-2)	840A 840B	*151589 *165803	
C8	Capacitor, electrolytic, 300 uf -10/+75%, 3V		151936	
C9	Capacitor, plastic, 0.047 uf ±10%, 50V		150300	
C10	Capacitor, ceramic, 0.05 uf -20/+80%, 25V 1 Capacitor, plastic, 0.047 uf ±20%, 250V		148924 162008	G H
C11	Capacitor, plastic, 0.1 uf ±20%, 40V		161992	
C12	Capacitor, tantalum, 0.47 uf ±20%, 35V		161349	
C13	Capacitor, ceramic, 0.05 uf -20/+80%, 25V 1 Capacitor, plastic, 0.047 uf ±20%, 250V		148924 162008	G H
C15	Capacitor, plastic, 0.047 uf ±10%, 50V		150300	
C16, C17	Capacitor, tantalum, 0.47 uf ±20%, 35V		161349	
C18	Capacitor, tantalum, 2.2 uf ±20%, 20V		161927	
L1	Inductor, variable wirewound, 22mh nominal		*151654	
Q6	Transistor, germanium, NPN, 2N1304		117127	
Q7	Transistor, germanium, PNP, 2N1307		148643	
Q8	Transistor, germanium, NPN, 2N1304		117127	
Q9	Transistor, germanium, PNP, 2N1307		148643	
Q10	Transistor, germanium, NPN, 2N1304		117127	
R3	Resistor, composition, 12 Meg ±10%, 1/2W		152744	
R16	Resistor, wirewound, 2499Ω ±0.02%, 1/2W Resistor, wirewound, 100Ω ±0.03%, 1/2W	840A 840B	*158592 *155846	
R17	Resistor, metal film, 68.1K ±1%, 1/2W		161083	
R18	Resistor, metal film, 19.6K ±1%, 1/2W		159640	
R19	Resistor, composition, 5.6K ±10%, 1/2W		108324	
R20	Resistor, composition, 10K ±10%, 1/2W		108118	
R21	Resistor, metal film, 1.37K ±1%, 1/2W		148874	
R22	Resistor, metal film, 634Ω ±1%, 1/2W		148866	
R25	Resistor, composition, 12K ±10%, 1/2W		108977	
R26	Resistor, composition, 56K ±10%, 1/2W		108472	
R27	Resistor, composition, 18K ±10%, 1/2W		108183	
R28	Resistor, metal film, 2K ±1%, 1/2W		151266	
R29	Resistor, composition, 8.2K ±10%, 1/2W		109017	
R30	Resistor, metal film, 22.1Ω ±1%, 1/2W		151472	

1 If replacement is required, use 162008

REFERENCE DESIGNATION	DESCRIPTION		FLUKE STOCK NO.	USE CODE
R31	Resistor, composition, 6.8K ±10%, 1/2W		108399	
R32	Resistor, composition, 8.2K ±10%, 1/2W		109017	
R33	Resistor, composition, 4.7K ±10%, 1/2W		108381	
R34	Resistor, composition, 3K ±5%, 1/2W		109090	
R35	Resistor, metal film, 200Ω ±1%, 1/2W		151480	
R36	Resistor, variable wirewound, 500Ω ±10%, 1/2W		112433	
T2	Magnetic Modulator	840A 840B	*165878 *165837	
T3	Transformer, 5 KC tunned	840A 840B	*151647 *165845	

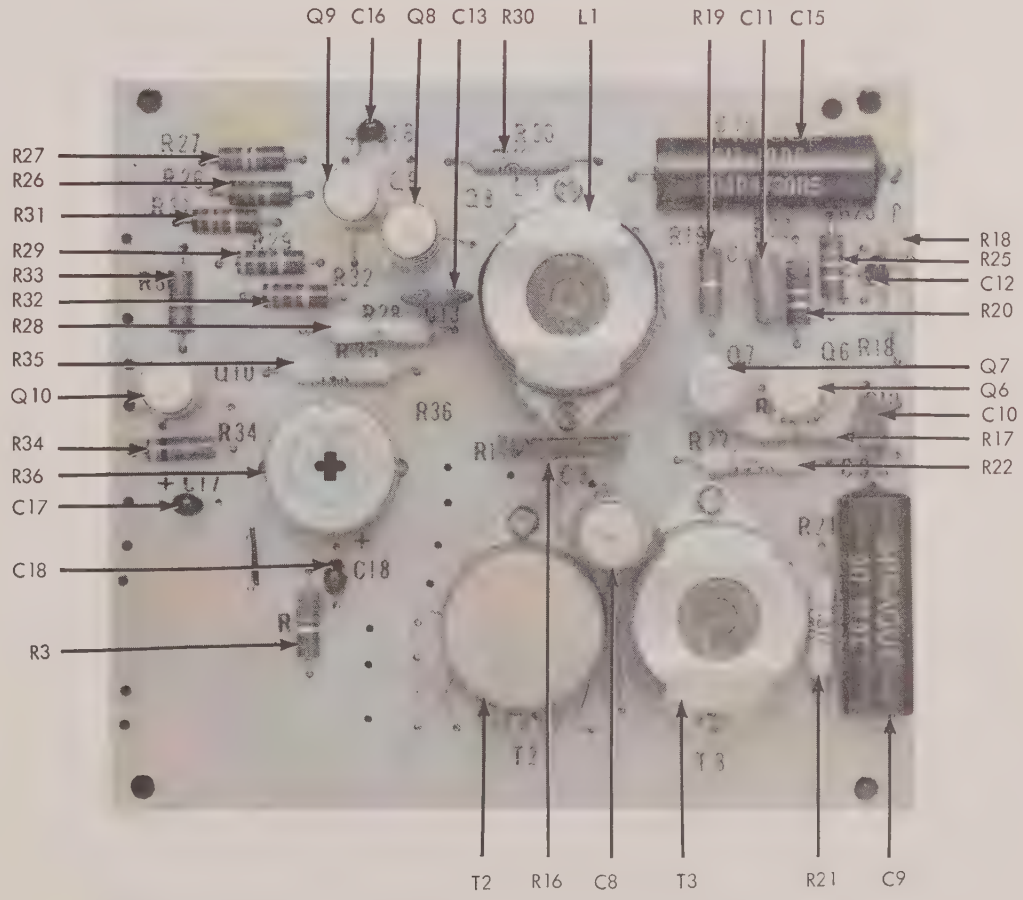


Figure 5-2B. MAGNETIC MODULATOR-CARRIER AMPLIFIER ASSEMBLY
(Serial Numbers 497 and on)

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
	NOTE: This assembly applies to serial numbers 123 to 496 only.		
	Oscillator-Synchronous Demodulator Assembly (See Figure 5-3)	*151597	
C1	Capacitor, electrolytic, non-polar, 100 uf -75/+10%, 15V	154914	
C2	Capacitor, plastic, 0.1 uf ±10%, 50V	150318	
C3	Capacitor, electrolytic, 15 uf -10/+100%, 6V	105700	
C4	Capacitor, tantalum, 4.7 uf ±20%, 6V (If replacement is required, use 161943)	106898	
C5, C6	Capacitor, ceramic, 0.1 uf -20/+80%, 25V (If replacement is required, use 161349)	148932	C
	Capacitor, tantalum, 0.47 uf ±20%, 35V	161349	D
C7	Capacitor, electrolytic, 100 uf -10/+100%, 3V	106534	
C20	Capacitor, electrolytic, 2 uf -10/+100%, 50V	105197	
CR1 thru CR3	Diode, germanium, 75 ma, 125 PIV	150342	
CR4 thru CR7	Diode, silicon, matched pair (CR4 matched to CR5 and CR6 matched to CR7)	*152918	
Q1, Q2	Transistor, germanium, NPN, 2N1304	117127	
Q3	Transistor, silicon, NPN, RCA 40053	150359	
Q4, Q5	Transistor, germanium, NPN, 2N1304	117127	
R5	Resistor, composition, 68Ω ±10%, 1/2W	108464	
R6	Resistor, composition, 22Ω ±10%, 1/2W	108670	
R7	Resistor, composition, 120K ±10%, 1/2W	108779	
R8	Resistor, composition, 2.2K ±10%, 1/2W	108605	
R9	Resistor, variable wirewound, 100Ω ±20%, 1-1/4W	112797	
R10	Resistor, composition, 270Ω ±10%, 1/2W	108241	
R11, R12	Resistor, composition, 18K ±10%, 1/2W	108183	
R13, R14	Resistor, composition, 6.8K ±10%, 1/2W	108399	
R15	Resistor, composition, 8.2K ±10%, 1/2W	109017	
T1	Transformer, oscillator	*151639	
T4	Transformer, demodulator	*151621	

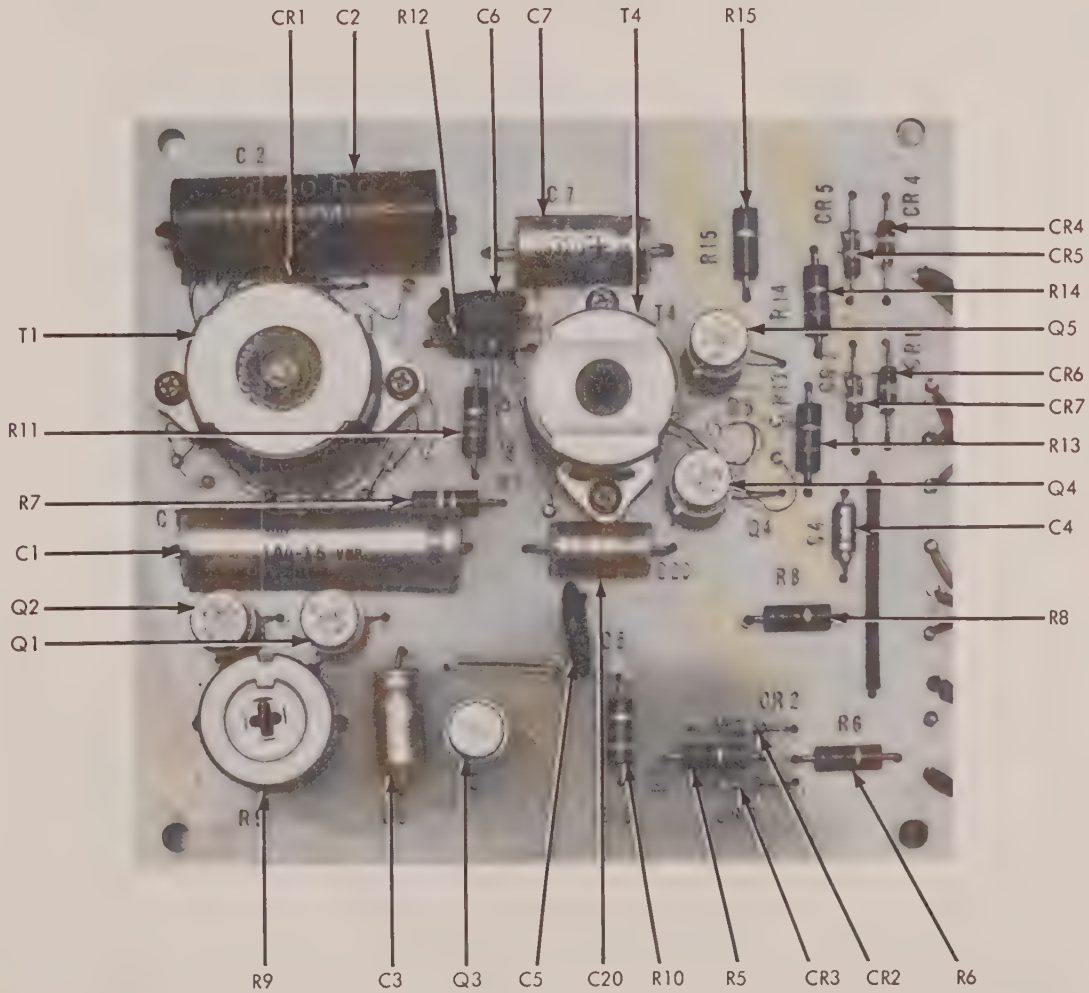


Figure 5-3A. OSCILLATOR-SYCHRONOUS DEMODULATOR ASSEMBLY
(Serial Numbers 123 to 496)

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
	NOTE: This assembly applies to serial numbers 497 and on only.		
	Oscillator-Synchronous Demodulator Assembly (See Figure 5-3)	*151597	
C1	Capacitor, electrolytic, non-polar, 100 uf -75/+10%, 15V	154914	
C2	Capacitor, plastic, 0.1 uf ±10%, 50V	150318	
C3	Capacitor, tantalum, 39 uf ±20%, 6V	163915	
C4	Capacitor, tantalum, 4.7 uf ±20%, 6V 1 Capacitor, plastic, 0.22 uf ±20%, 35V	106898 161943	E F
C5, C6	Capacitor, ceramic, 0.1 uf -20/+80%, 25V 2 Capacitor, plastic, 0.1 uf ±20%, 250V	148932 161992	E F
C7	Capacitor, electrolytic, 100 uf -10/+100%, 3V	106534	
C14	Capacitor, ceramic, 0.1 uf -20/+80%, 25V 2 Capacitor, plastic, 0.1 uf ±20%, 250V	148932 161992	E F
C19	Capacitor, tantalum, 0.47 uf ±20%, 35V	161349	
CR1, CR2	Diode, germanium, 75 ma, 125 PIV	150342	
CR4 thru CR7	Diode, silicon, matched pair (CR4 matched to CR5 and CR6 matched to CR7)	*152918	
Q1,Q2	Transistor, germanium, NPN	*153551	
Q3	Transistor, silicon, NPN, RCA 40053	150359	
Q4, Q5	Transistor, germanium, NPN, 2N1304	117127	
R5	Resistor, composition, 75Ω ±5%, 1/2W	108753	
R6	Resistor, variable wirewound, 50Ω ±20%, 1-1/4W	112490	
R7	Resistor, composition, 120K ±10%, 1/2W	108779	
R8	Resistor, composition, 2.2K ±10%, 1/2W	108605	
R10	Resistor, composition, 270Ω ±10%, 1/2W	108241	
R11, R12	Resistor, composition, 18K ±10%, 1/2W	108183	
R13, R14	Resistor, composition, 6.8K ±10%, 1/2W	108399	
R15	Resistor, composition, 8.2K ±10%, 1/2W	109017	
T1	Transformer, oscillator	*151639	
T4	Transformer, demodulator	*151621	

1 If replacement is required, use 161943
2 If replacement is required, use 161992

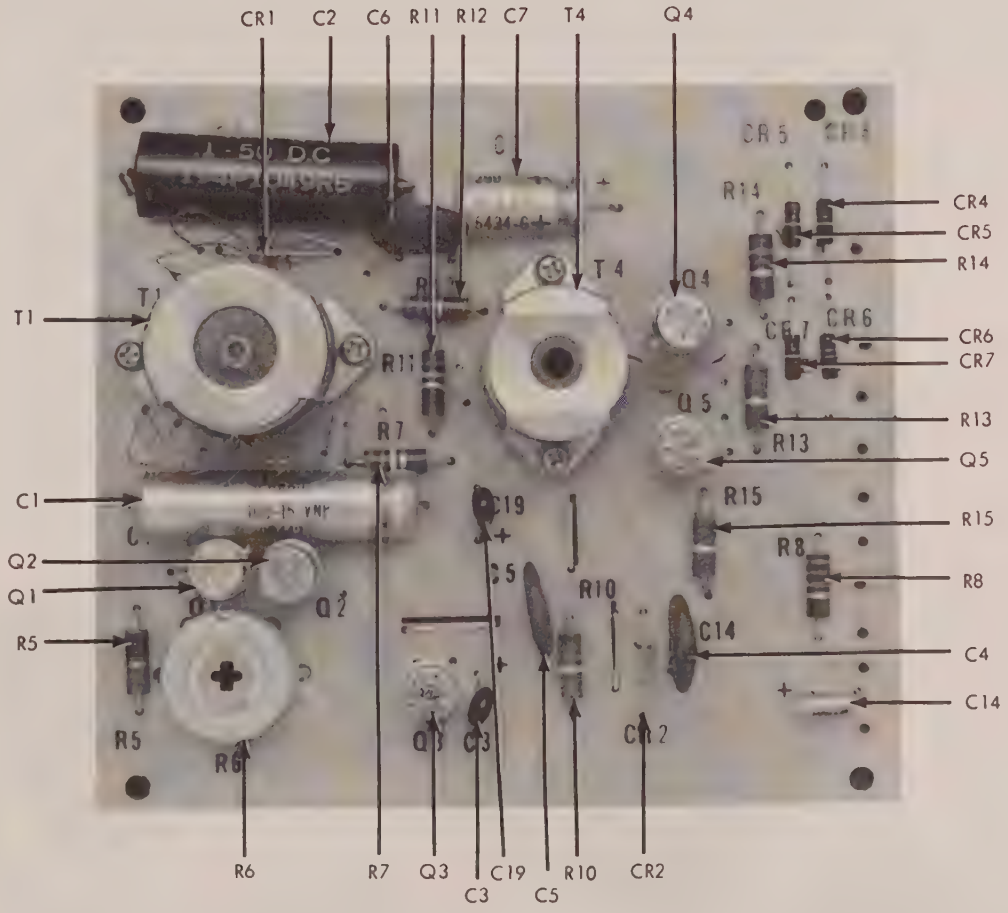


Figure 5-3B. OSCILLATOR-SYCHRONOUS DEMODULATOR ASSEMBLY
(Serial Numbers 497 and on)

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
	Auxiliary Power Supply	A84-3	
C1, C2	Capacitor, electrolytic, 200 uf -10/+75%, 12V	150284	
CR1, CR2	Diode, germanium, 75 ma, 125 PIV	150342	
CR3	Diode, zener, 14V ±5% at 9 ma	150334	
R1, R2	Resistor, composition, 10K ±10%, 1W	109389	
R3, R4	Resistor, composition, 100Ω ±10%, 1/2W	108100	
T1	Transformer	160192	
	Plug	160275	

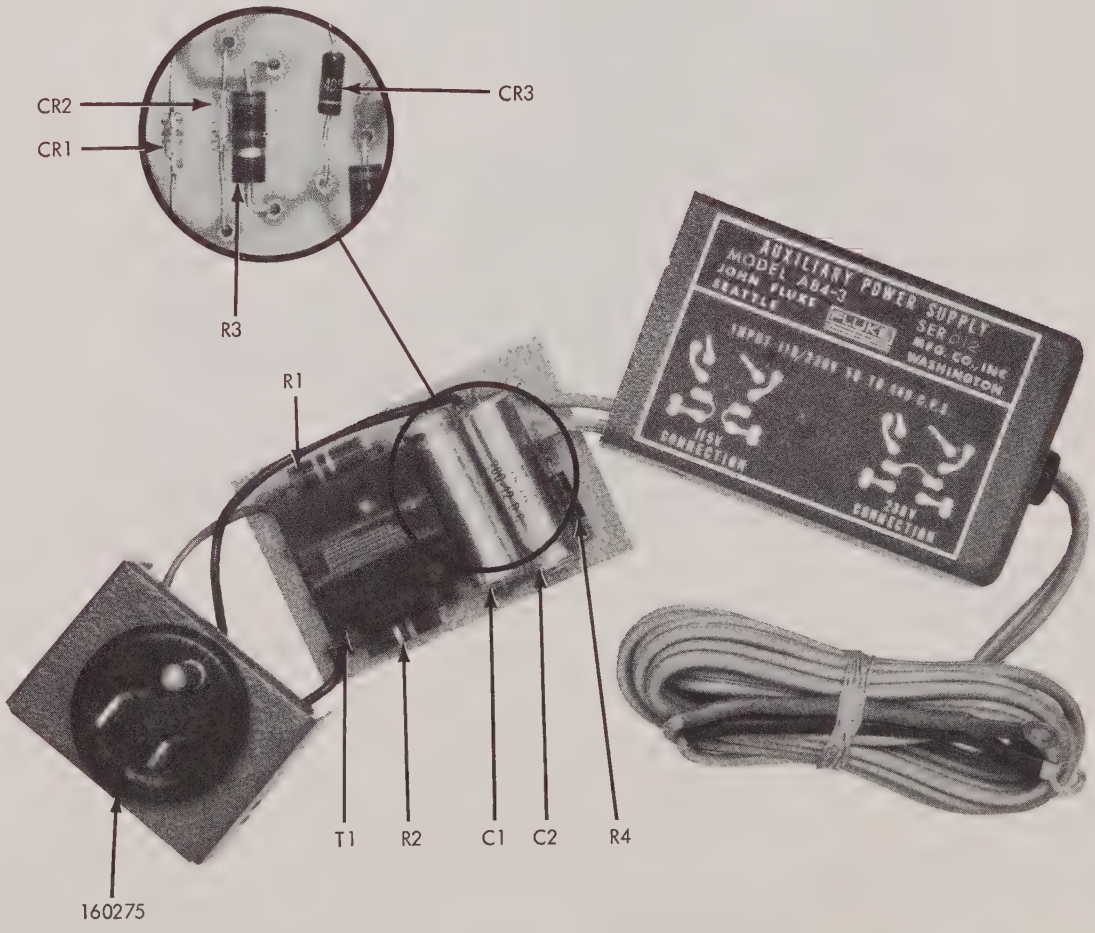


Figure 5-4. AUXILIARY POWER SUPPLY

5-3 USE CODE EFFECTIVITY

The following list of use codes is intended to allow the customer to determine the effectivity of all replaceable parts. All parts with no code are used on all instruments with serial numbers above 123. New codes will be added as necessary on forthcoming instruments.

USE CODE	EFFECTIVITY
No Code	Model 840A serial number 123 and on
A.	Model 840A & 840B serial number 123 to 496 except 298, 301, 302, 305, and 306.
B.	Model 840A & 840B serial numbers 298, 301, 302, 305, 306, and used as a substitute from 447 to 496.
C.	Model 840A & 840B serial number 123 to 496 except 298, 301, 302, 305, and 306.
D.	Model 840A & 840B serial numbers 298, 301, 302, 305, and 306.
E	Model 840A & 840B serial numbers 123 to 690**.
F	Model 840A & 840B serial numbers 691** and on.
G	Model 840A & 840B serial numbers 123 to 699**.
H	Model 840A & 840B serial numbers 700** and on.

** Indicates approximate serial number.

WARRANTY

The JOHN FLUKE MFG. CO., INC. warrants each instrument manufactured by them to be free from defects in material and workmanship. Their obligation under this Warranty is limited to servicing or adjusting an instrument returned to the factory for that purpose, and to making good at the factory any part or parts thereof; except tubes, fuses, choppers and batteries, which shall, within one year after making delivery to the original purchaser, be returned by the original purchaser with transportation charges prepaid, and which upon their examination shall disclose to their satisfaction to have been thus defective. If the fault has been caused by misuse or abnormal conditions of operation, repairs will be billed at a nominal cost. In this case, an estimate will be submitted before work is started, if requested.

If any fault develops, the following steps should be taken.

1. Notify the John Fluke Mfg. Co., Inc., giving full details of the difficulty, and include the Model number, type number, and serial number. On receipt of this information, service data or shipping instructions will be forwarded to you.

2. On receipt of the shipping instructions, forward the instrument prepaid, and repairs will be made at the factory. If requested, an estimate of the charges will be made before the work begins, provided the instrument is not covered by the Warranty.

SHIPPING

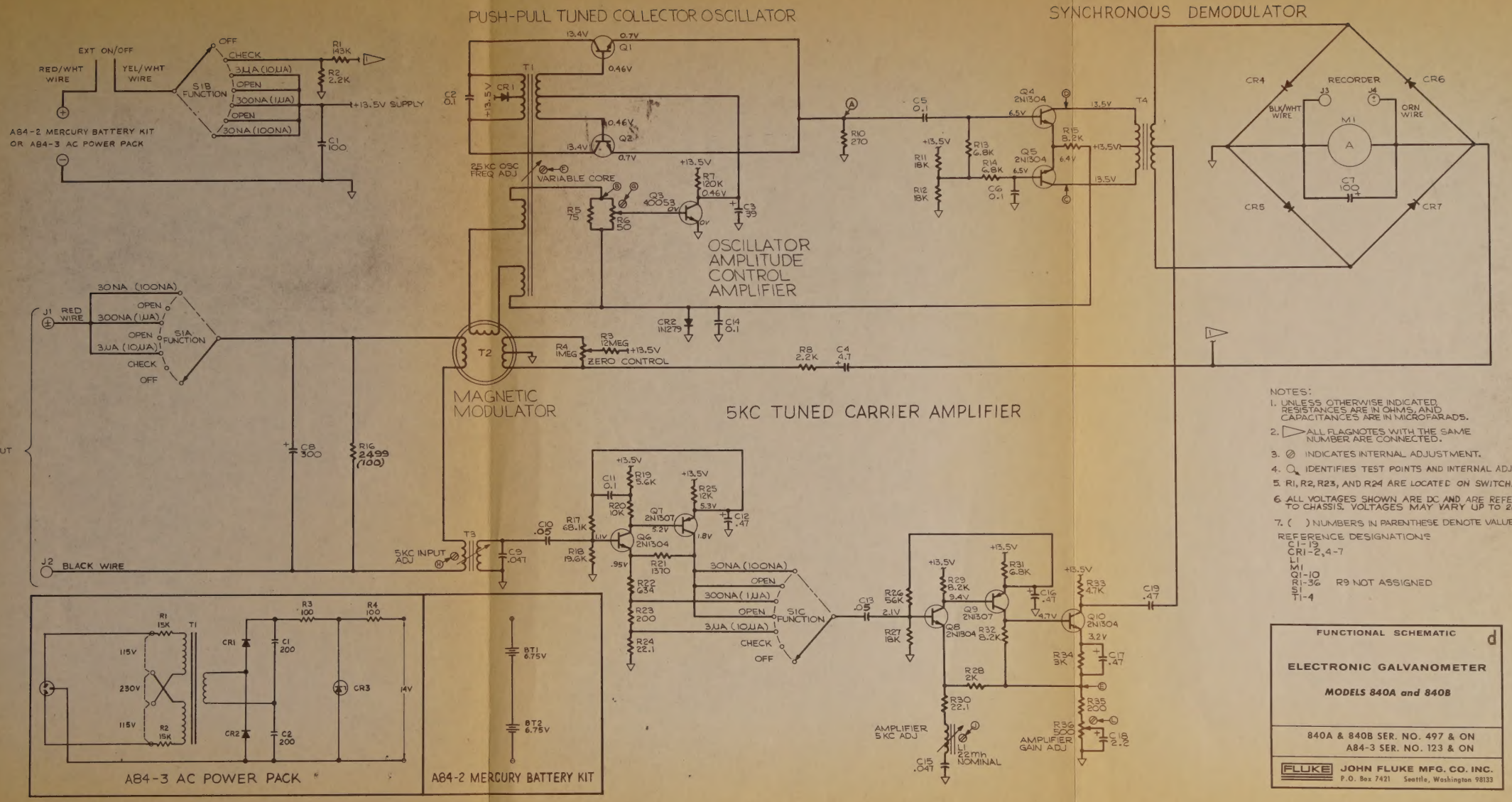
All shipments of John Fluke Mfg. Co., Inc. instruments should be made via Railway Express prepaid. The instrument should be shipped in the original packing carton; or if it is not available, use any suitable container that is rigid. If a substitute container is used, the instrument should be wrapped in paper and surrounded with at least four inches of excelsior or similar shock-absorbing material.

CLAIM FOR DAMAGE IN SHIPMENT

The instrument should be thoroughly inspected immediately upon receipt. All material in the container should be checked against the enclosed packing list. The manufacturer will not be responsible for shortages against the packing sheet unless notified immediately. If the instrument fails to operate properly, or is damaged in any way, a claim should be filed with the carrier. A full report of the damage should be obtained by the claim agent, and this report should be forwarded to John Fluke Mfg. Co., Inc. Upon receipt of this report you will be advised of the disposition of the equipment for repair or replacement. Include the model number, type number, and serial number when referring to this instrument for any reason.

The John Fluke Mfg. Co., Inc. will be happy to answer all application questions which will enhance your use of this instrument. Please address your requests to:

JOHN FLUKE MFG. CO., INC., P. O. BOX 7428, SEATTLE 33, WASHINGTON



NOTES:

1. UNLESS OTHERWISE INDICATED RESISTANCES ARE IN OHMS, AND CAPACITANCES ARE IN MICROFARADS.
2. ▷ ALL FLAGNOTES WITH THE SAME NUMBER ARE CONNECTED.
3. ⊘ INDICATES INTERNAL ADJUSTMENT.
4. ○ IDENTIFIES TEST POINTS AND INTERNAL ADJUSTMENTS.
5. R1, R2, R23, AND R24 ARE LOCATED ON SWITCH.
6. ALL VOLTAGES SHOWN ARE DC AND ARE REFERENCED TO CHASSIS. VOLTAGES MAY VARY UP TO 20%.
7. ( ) NUMBERS IN PARENTHESE DENOTE VALUE USED IN 840B

REFERENCE DESIGNATIONS

C1-13
CR1-2,4-7
L1
M1
Q1-10
R1-36 R9 NOT ASSIGNED
S1
T1-4

FUNCTIONAL SCHEMATIC d

ELECTRONIC GALVANOMETER

MODELS 840A and 840B

840A & 840B SER. NO. 497 & ON
A84-3 SER. NO. 123 & ON

FLUKE JOHN FLUKE MFG. CO. INC.
P.O. Box 7421 Seattle, Washington 98133

87264